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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 339).*

Forthcoming Events.

MARCH 24.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Some Notes on the Section and Examination of Materials for Driving-Chain Manufacture," Paper by J. Dickson Hannah, B.Sc., F.I.C.

Institute of British Foundrymen.

MARCH 20.

Sheffield and District Branch:—Ordinary meeting. "The Manufacture of High-class Marine Propellers," Paper by Wesley Lambert, C.B.E.

MARCH 21.

Scottish Branch:—Annual general meeting at the Royal Technical College, Glasgow.

MARCH 27.

Birmingham, Coventry and West Midlands Branch:—Ordinary meeting at Birmingham. "The Melting of Cast Iron," Paper by T. G. Bamford, M.Sc.

Still At It!

The important body known as the National Confederation of Employers' Organisations, a group of associations of manufacturers, has carried on the good work of emphasising the crippling effects on industry of high public expenditure and high taxation. It has issued a statement, which has been sent to all Members of Parliament. It declares that the chief handicaps to British trade are our high standards of living and social services compared with our competitors, the lack of relationship between wages and world prices (which fix the prices we can get for our exports), excessive public expenditure and legislative restrictions on industry.

The report urges no further increase in civil servants and employees of local authorities, a committee of national economy, with power to fix the maximum we can afford to spend on social services, and an immediate reduction in unemployment benefit by one-third, being confined in any case to those who have six contributions for every claim they make.

It goes on to urge no further legislation restricting trade or industry until unemployment is down to 5 per cent., and a reduction in the wage levels of the sheltered industries, the largest sheltered industry in the country being the Civil Service and local authorities' service. Rationalisation is declared to be no remedy, for it is equally open to our competitors. If the taxation, wages and social service costs in Britain be each represented by 100, the corresponding German figures are 50, 74 and 48; in France, 64, 59 and 17; in Belgium, 38, 50 and 7; in Italy, 30, 45 and 4. Before the present depression, even though world trade had increased 25 per cent., our exports had fallen 20 per cent. against 1913. Yet taxation absorbs nearly a quarter of the total income, although only four persons in a hundred pay income tax. The report views with alarm the payment of wages by local authorities higher than the rates possible to the exporting industries, and says that the expenditure of public money on relief works, drawn from rates paid by industry, may actually intensify the unemployment it pretends to alleviate. The De-rating Act is the only attempt made to diminish burdens on industry.

The National Confederation is the largest employers' association in the world, and represents the organisation of manufacturers employing over seven million workers in Britain. It is safe to say that in no country in the world are employers politically so helpless to modify the conditions now prevailing.

Constructive Design.

For some time now we have been lauding the welding industry on the acumen they display in relieving the engineering designer of the major portion of his work by drawing out for him structures suitable for incorporating the best to be obtained within their industry. Thus it gave us a considerable pleasure to read Mr. Edwards' article, which appears elsewhere in this issue, on "Testing Castings." Both he and his firm, Messrs. W. & T. Avery, Limited, are to be congratulated on the sanity of the methods used for the collection of data for the rationalisation of the design of iron castings.

We have been hesitating for some months whether or not to advocate for Great Britain the organisation of an association to emulate the work of the American Grey Iron Institute, but we have reached the conclusion that individual effort by the various firms can accomplish the work of popularising grey-iron castings equally well. Whenever a mass-production job is offered to a foundry, permission should be sought for the co-operation of the bidder's own castings-designing department, stressing the fundamental principles that it may be possible to give a stronger yet lighter job. Rigidity, resistance to abrasion, wear and corrosion, and machinability are all selling points for grey-iron castings, whilst with modern control quite high tensile figures can be produced. The lack of elasticity is not invariably a disadvantage; in fact, for many jobs the reverse is desirable. When in competition with weldings, emphasis should be laid on the fact that the strength of the wrought structures is to some extent neutralised by the small castings which form the joints; that quite often a dent is as disastrous as a fracture; that the thin steel plates are subjected, under certain conditions, to rapid corrosion; that if weldings are superior to castings, how is it that many inspecting authorities will not allow even minor skin defects on castings to be made good by this process? We are convinced that the majority of the founders in Great Britain are aware of the potentialities of the metals they handle, and subtle, yet enlightened, propaganda by their thousands of representatives will ultimately achieve better and more lasting results than by a co-operative campaign designed to popularise and increase the use of castings.

Finally, we may change our outlook if we find competing industries making serious inroads by co-operative measures, but at the moment more work on the lines of that carried out in the Soho Foundry will render co-operative action unnecessary.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Belgian Sand.

To the Editor of The Foundry Trade Journal.

Sir,—We have read Mr. Pitts' letter of March 8 with interest, but do not see the faintest reason why he should have assumed that our advertisement of March 5 had any reference to his activities or those of his firm.

We are glad, however, he has written, because, with your kind permission, we are given an opportunity of emphasising that in these black days of depression, when the old country is fighting for her industrial life, it is of paramount importance that all who wish her well should unite to reduce imports and to purchase from abroad nothing that can be supplied at home.

This applies as much to foreign sands as it does to foreign castings, foreign motor cars, foreign magnesite bricks and foreign steel, and the more nearly self-supporting we are in Great Britain the better off we shall be.—Yours, etc.,

For General Refractories, Limited,
Frank Russell,
Managing Director.

Wicker Arches, Sheffield,
March 14, 1931.

Blast-Furnace Reactions.

To the Editor of The Foundry Trade Journal.

Sir,—We have available the results of recent experimental investigation on a commercial blast furnace which enable us to test the validity of Mr. Fletcher's new views on the smelting process given in detail in your current issues. These investigations were undertaken by the Bureau of Mines, U.S.A., and are to be found published in their Technical Paper 397, entitled "Composition of Materials from Various Elevations in an Iron Blast Furnace," by S. P. Kuiney, dated 1926. I venture to place a summary of the results of these investigations in contrast with Mr. Fletcher's views.

I presume that a concise statement of Mr. Fletcher's new views is to be obtained in his own words from page 176 of your issue dated March 5, 1931, wherein he states that he "has long held the view that the liquid carburised sponge iron is alloyed with silicon, manganese and phosphorus in the (blast) furnace hearth, whilst in contact with the slags, etc."

The conclusions drawn from the actual experiments referred to above are set out as follow:—

(1) Eighty to 85 per cent. of the iron in the burden was reduced to the metallic form by the time it reached a level 19¼ ft. above the tuyere level.

(2) The metal in the form of sponge iron had taken up or was in intimate contact with considerable quantities of carbon, sulphur, phosphorus, manganese and silicon at a level 19¼ ft. above the tuyere level and 8 ft. above the bosh level.

(3) More than 33⅓ per cent. of the carbon had been taken up by the metal by the time it reached the level 19¼ ft. above the tuyeres; the remainder was taken up whilst the metal was in the bosh and before it reached the level of the tuyeres.

(4) About 87 per cent. of the silicon entering the metal was taken up whilst the metal was in the bosh above a plane 27 in. above the tuyere level. A further 12 per cent. was taken up between this plane and the centre line of the tuyere.

(5) Approximately 33⅓ per cent. of the manganese entered the metal, or was in intimate association with it, above a plane 19¼ ft. above tuyere level. Between this level and a level

(*Concluded on page* 205.)

The Late Mr. W. H. Poole.

We sincerely regret to announce the death, at the age of 44 years, of Mr. W. H. Poole, a founder and managing director of the Keighley Laboratories, Limited, South Street, Keighley, Yorks. This took place on Wednesday, March 11, following an abdominal operation.

Mr. Poole was a leading figure in the foundry world, a prominent member of the Institute of British Foundrymen, a member of the Iron and Steel Institute and an enthusiastic Rotarian. He joined the Institute of British Foundrymen in 1922, and from that time onwards read Papers before several branches and was awarded the Institute Diploma for a Paper on cupola practice, and his contributions to discussions were invariably extremely helpful.

His early metallurgical training was obtained in the foundries and laboratories of the Rudge-Whitworth Company, Limited, and the Rover Company, Limited, Coventry. From 1906-12 he was chemist and metallurgist to the Daimler Motor Company, Limited, being directly responsible for all the metallurgical side of the grey-iron, steel and non-ferrous foundries, carrying out extensive pioneer work in the production of steel castings by the Stock process.

In 1912 he went to Detroit, U.S.A., for the Ottawa Conveyor Company, establishing an electric-steel foundry in that city. Returning to this country in 1914, he was appointed metallurgist to Thwaites Bros., Limited, Bradford, and was engaged chiefly in the production of electric-steel castings during the war period.

In 1920, along with a group of Keighley engineers, he founded the company of Keighley Laboratories, Limited, consulting metallurgists and analytical chemists, with the object of providing a co-operative research and routine testing and consulting service for the local foundries, but it rapidly grew to cover a much wider sphere of activity. Amongst the many and varied activities of the company, one of the most interesting was the provision of teaching facilities, in the form of evening classes, for local foundry and engineering apprentices in metallurgical science, in conjunction with the Keighley Technical College, under the West Riding County Authority.

Mr. Poole leaves a widow and young family, and to them we offer our deepest and most sincere sympathy—a sentiment which will be general throughout the whole of the British foundry industry.

The funeral took place on Saturday, March 14, at Nab Wood Cemetery, and was largely attended by well-known metallurgists, foundrymen and engineers.

The work of the Laboratories is being carried on by his brother, Mr. H. F. Poole, who has been on the staff since its inception.

Notes from I.B.F. Branches.

Scottish Branch.—In connection with the coming-of-age celebrations of the Scottish Branch of the Institute of British Foundrymen, there is being carried out an intensive campaign to increase the membership. The members of council are arranging personal interviews with principals of those firms who are not represented, or inadequately represented, in the Branch membership with a view of putting before them the aims and objects of the Institute.

Brussels International Commercial Fair.—This fair is to be held from April 8 to 22, 1931. For further information apply to: The Belgian Embassy and Consulates, or Head Office of Belgian Railways, 47, Cannon Street, London, E.C.4; or Belgian Chamber of Commerce, 8, Union Court, Old Broad Street, London, E.C.2.

Random Shots.

The Swedish Exhibition of Industrial Arts and Crafts, opened on Tuesday by H.R.H. Prince Eugen of Sweden, should attract founders to Dorland House if only because of the exhibit of art castings which is to be found among the many examples of bookbinding, china and glass, furniture, pewter-work, textiles and embroidery produced by Swedish craftsmen. This rather gives the impression that I personally have visited the Exhibition, which is not yet the case. But—unless the Editor takes the wind out of my sails—I hope to become lyrical about these art castings next week. The object of the Exhibition is to demonstrate that, by establishing collaboration between artists and producers, it is possible to achieve beauty in articles mass-produced for everyday household use. Why not start upon the humble beer-bottle? It very much requires beautifying and is certainly mass-produced! Thus simply could art be brought permanently into millions of homes.

* * *

Writing of art in the home reminds me of the story anent the landlady who said to her lodger, a struggling young artist: "Good morning, Mr. Landseer. And how would you like your potatoes to-day? In their jackets or in the nude?"

* * *

Other London exhibitions include Madame Tussaud's, to which the latest addition is a model of the late Alfred Arthur Rouse, and the one in the House of Commons, which, however, is thought to suffer from bad arrangement and lack of light.

* * *

All these facts will be printed in the daily newspapers this week: The Oxford and Cambridge Boat Race has been rowed 83 times; the first was in 1829; it has been rowed yearly since 1856 (except during the war years); the 1877 race finished in a dead-heat; Oxford has won 40 contests, Cambridge 41; the crews aren't what they used to be; Oxford will win if Cambridge loses; Cambridge will win if Oxford doesn't row; and so on. Each year the Press exhibits similar marked originality. It is now illustrating the straw hats and cricket balls which will be used this summer. The appearance of these photographs, I find, generally falls within the last two weeks of winter.

* * *

Amidst the multitude of conveyors at Messrs. Henry Ford & Sons' foundry at Cork, the English visitors took a profound interest in the patterns bearing the following identifications:—C/J A 2,619, 2,622, 2,624, 2,625, 2,626 and 2,628, mainly because they were, unlike all the other patterns, a 25-off job.

Marksman.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page* 190.)

No. 1. SALES LETTERS—(*continued*).

It is assumed that the reader understands what a sales letter is, and therefore no attempt will be made here to discuss the part such communications play in selling and advertising campaigns. It is the form, structure and text of the sales letter that make up the substance of this article. At the same time, since, as has been said, good writing begins in the mind of the writer, it is necessary to point out that sales letters are of two kinds, form-letters and follow-up letters. The reason for drawing this distinction is that they affect the state of mind of their writer. A form letter is a widely-circulated letter sent out simply and solely to attract business. It has no reference to previous correspondence or communications. The writer of such a letter has no direct clue to the character and attitude of the person who receives it. He must, therefore, put himself into the frame of mind of the politician. He must address himself to a large number in such a way as to gain their attention, and lead them to take the action he desires. His literary appeal must be generalised.

The Follow-up Letter.

The follow-up letter, on the other hand, as its name suggests, follows up previous communications. It is an endeavour to reawaken interest, to bring business, or to clinch matters that hang fire. It is true that sometimes follow-up letters are merely form letters sent to all the people who have failed to answer a first sales letter. But even so, the people who have not answered are less generalised than in the first instance. They are, definitely, men who have ignored a letter. They can be addressed as such, in certain circumstances. They have exhibited some characteristic, if only that of indifference. The writer, before beginning a follow-up letter, knows one fact about them if no more, namely, that they are men not won at the first attempt. His follow-up letter must, therefore, lose a little of its first amiable politeness and generality, and become more direct and particular.

To understand the difference this division into two broad classes makes is important, because it enables the writer to have a clear notion of his objective, and helps him to achieve the proper state of mind preparatory to the composition of his letter.

The writer must understand, also, exactly what he is trying to do when he composes a sales letter. He is coldly and calmly trying to induce a number of men whom he does not know to buy something that he has to sell. What this means is best indicated in the following: It means that he is asking a man to spend his money; that he is offering him something unknown or untried; that he is trying to overcome a man's reluctance to spend; that he is competing in this with a hundred or more other writers; that he is addressing himself to a man who is bored by such appeals; that his correspondent does not want to read his letter; that his correspondent is sceptical, critical, irritable; that his claims will only be believed if substantiation is possible and easy; that the claims most interesting to his correspondent are those not being made by competitors; that everything depends on the impression created by the first few lines of his letter; that the final test of his letter's quality lies in whether or not the correspondent takes the action desired.

A full perception of these difficulties will leave the letter-writer with the conviction that a genuine mental effort is required to compose a good sales letter. Nothing is truer, and good sales-letter writers are men not afraid to make this effort and who can command a high salary in almost any market. But the effort must be made, and the ability to make it quickly and successfully has first to be acquired. There is no royal road other than hard work and patience grafted upon natural talent.

The First Sentence.

The most frequent and most easily-cured fault of the novice is excessive length. There are few writers who have not found their chief difficulty to lie in beginning a letter. The first sentence simply refuses to come, and until it does the letter remains unwritten. Eventually it arrives, and the writer pours out a spate of words and carries his letter to a triumphant conclusion. That moment of conclusion is the precise moment when the real work of writing begins.

It is certain that the first sentence, when finally achieved, will prove to be the tamest and most platitudinous of generalisations. Even skilled and experienced writers often need some clumsy generalisation to set them going, but after they have finished they invariably go back and cut out that opening remark. Sometimes the whole opening paragraph can be cut out without loss to the letter. An example will perhaps most fitly indicate the error of retention. A letter reached the author the other day beginning: "In these days of fierce competition every buyer must closely study the question of getting maximum economy from the goods he orders."

It is at once obvious that this platitudinous, long-winded opening sentence helped the writer to get going. But he made the mistake of not cutting it out after he had finished. Consider the sentence in the light of the table given earlier. What does it add to the value of the letter as a means of selling something to a man who does not want to buy? It is addressed to buyers, and what buyer needs to be told what his business is? It certainly contains no lies, but at the same time it gives no facts about the thing to be sold. It is insipid and full of hackneyed phrases (*e.g.*, "fierce competition," "maximum economy"). It is a general remark, and its effect on the busy reader is to make him feel sure, rightly or wrongly, that there is nothing in the letter worth bothering about. Accordingly, he tears it up, and it finds a grave in the waste-paper basket.

On the other hand, a letter received by the author some years ago, and never since forgotten, began: "Have you thought of getting badges for your stand attendants at Birmingham?" His attention was arrested at once. The idea of badges had never previously occurred to him. The letter continued by explaining why badges were advantageous, how much they cost, the kinds that could be supplied, the time required for delivery. Every word had a direct bearing on the goods, and not one was superflous. All weak general remarks had been eliminated. Facts alone were admitted.

The Golden Rule.

The golden rule in the writing of sales letters is to remember that what interests the buyer is *what the goods will do for him*, and not what the manufacturer thinks about them himself. The letter-writer must, therefore, before he begins, have ascertained and have fixed clearly in his mind the worth of his goods to the particular buyer or class of buyers he is addressing. He must not assume that his own facile enthusiasm, as one who is employed by the maker and knows the good points of the article, is sufficient to convince. It would be a good thing if every sales-letter writer would put himself into the state of mind of a man writing to a personal friend, whom he would not deceive, about an article that he is sure will help him out of a known difficulty. This does not mean that the letter should be written in the flippant, pseudo-amiable style, but only that a genuine desire to help should be the apparent, and as far as possible the real, motive in writing. At the risk of becoming tedious, the author stresses the point that good writing is the result of a correct state of mind. A sincere wish to bring something good and useful to the buyer's notice is the right attitude here.

The sales letter must, like a good advertisement, arouse attention, create and sustain interest, awaken desire and induce action. But it has one great advantage over the advertisement in that it has the flavour of a private communication, and can therefore say what it has to say more directly and personally. At the same time, it must avoid undue familiarity of tone or levity. Its length should be the exact number of words requisite to convey its message, no more and no less. The crisper and more direct the letter, the likelier it is to be read. At the same time, excessive condensation is as bad as prolixity if the result is to cloud the meaning or render the letter harsh and abrupt.

Correspondence.

(*Continued from page* 204.)

27 in. above the tuyeres, the metal took up considerable manganese, part of which probably was oxidised later in the tuyere zone.

(6) All of the phosphorus had entered the metal by the time it reached a level 27 in. above the tuyeres. Approximately one-half of the phosphorus had entered or become intimately combined with the metal at a level of 19¼ ft. above the tuyeres.

(7) Sulphur was readily taken up in the upper part of the furnaces.

The conclusions from these experiments appear completely to discredit Mr. Fletcher's new views, and for this reason, I am sure, his comments will be welcome.—Yours, etc.,

J. E. Hurst.

"The Beeches," Green Lane,
Dronfield, nr. Sheffield.
March 16, 1931.

Railway Classification of Grey-Iron Castings.

To the Editor of The Foundry Trade Journal.

Sir,—The General Railway Classification of Goods is a mysterious document, in the compilation of which reason and logic have probably played no large part.

Is it reasonable or logical that malleable castings—with no stipulation as to weight per casting or method of packing—should be conveyed at Class 10 rates, while iron or steel castings "of light type" in less than 2-ton lots are charged at Class 17? Even if the iron or steel castings are packed in cases, they are still only in Class 13.

We feel that if the railway companies are prepared to carry malleable iron at Class 10 rates, it is unfair that grey-iron and steel castings should not receive equal terms. To allow for the extra risk of breakage of grey-iron castings as against malleable, the railway companies would presumably only accept the former at owner's risk, unless properly protected by packing.

We have taken the matter up with our local goods agent, and we hope that other foundries in other parts of the country will do the same. The difference is very considerable, and it is worth while for the grey-iron foundry industry to make some effort to get this anomaly put right.—Yours, etc.,

The Storey Foundry Company, Limited.
Sheffield Street, Heaton Norris, Stockport,
March 10, 1931.

D

Institute of British Foundrymen.

ANNUAL DINNER OF THE EAST MIDLANDS BRANCH.

The annual dinner of the East Midlands Branch of the Institute of British Foundrymen was held at the Great Central Hotel, Loughborough, on March 7. Mr. T. Goodwin (Branch-President) presided over a company of about 80.

The principal guests included Dr. H. Schofield, M.B.E., Ph.D., B.Sc., Principal of the Loughborough College; Mr. T. Makemson, General Secretary of the Institute; Mr. E. J. Fox, managing director of the Stanton Ironworks Company, Limited; Dr. W. A. Richardson, B.A.; Councillor P. Turner, Mayor of Loughborough; Mr. W. H. Purnell, of Messrs. Herbert Morris, Limited; Mr. S. H. Russell; Mr. G. Tate; Mr. W. H. Proctor; Major Athey and Mr. J. S. Driver.

Educational Standard of Entrants to the Industry.

After the toast of "The King" had been proposed by the President, Dr. H. Schofield, proposing the toast of "The Institute of British Foundrymen," said that he had to congratulate the Institute on its progressive educational policy. Education was an essential, and, with particular regard to foundry work and practice, his department was making an effort towards part-time proposals for boys in the foundry. He thought that before the better education aimed at could be taken full advantage of, the industry needed youths of a higher standard of education than it was receiving at present.

He had had the pleasure and privilege of visiting the United States and Canada to study the educational training facilities provided in the schools and colleges in those countries, and he was extremely impressed by the practicability of the training given. In this country emphasis was given in the wrong direction—to the academic success of the students, whilst one rarely heard of them getting first-class situations. It would be a far more satisfactory proof of the success of educational training if the whole of the products of the schools obtained first-class jobs. In Chicago he saw splendidly-equipped foundries in the schools for secondary boys, where they obtained a knowledge of practical moulding.

The City and Guilds of London Institute, in association with the technical institutions, was arranging for an examination on foundry subjects, which would, the speaker thought, show that a better material would be required for better education.

Mr. T. Makemson, responding to the toast, said it was gratifying and helpful to receive the advice and encouragement of the educationist. The City and Guilds of London authorities were arranging with one of the Institute's committees a foundrywork section, which would be included in the syllabuses next winter. The material entering was not as bad as Dr. Schofield would have them believe. One could not make good foundrymen by getting the boys to pass examinations. Whilst technical knowledge was of extreme importance, certainly the establishment of a certificate in foundry work would give increased prestige to the industry in all parts of the country. The Institute received good support—especially in the East Midlands district—from firms, but not so many of them as one might desire. They were prepared to take the benefits obtained, and in view of the Institute's work for the foundry industry, he considered that it should have greater support and appreciation. On behalf of the Institute he appreciated the toast submitted by Dr. Schofield.

Protection for the Pig-Iron Industry?

Mr. E. J. Fox, proposing the toast of the East Midlands Branch, said that the Branch was one of the most successful Branches he knew of amongst the scientific societies. It was possible to realise by the atmosphere of the meeting the strides and advancement the members had made since the time when the Branch was founded, 15 years ago, with a membership of 46; to-day it was 140. The Branch covered a very wide and extensive area, and it was the first to institute a technical library. He thought they would agree that its success was, in no small measure, due to the Past-Presidents retaining their interest in after years, thus enabling the Branch to maintain a mentally healthy condition.

He said that the interests with which they were associated were feeling the strain of the present world condition. Thirty per cent. of the iron founders were out of employment more than 12 months ago. In this country and Northern Ireland there were 7,000 foundries, of which 3,000 were iron foundries. There were 2,000 in Germany and 1,500 in France. It was computed that every two years 50 were put out of operation and 25 set up in this country.

Derbyshire, Lancashire and Northamptonshire were largely producers of pig-iron. Mr. Fox stated that the pig-iron producer required no protection, but if his customers who manufactured the saleable articles required protection, then pig-iron might require it, and must have it, he could not help thinking, if it was a necessity to have a high quality of cast iron. Steel scrap could be used in many cases and would considerably lower the cost of pig-iron per ton, but in many foundries they were afraid to use it for fear of blow-holes, etc. But with efficient cupola control it could be mixed quite well and with successful results. He coupled the toast to the East Midlands Branch with the name of Mr. T. Goodwin.

In responding, Mr. Goodwin said that the reason why the Branch was so successful was because of its very able Presidents. Whilst the area covered by the Branch was a wide one, its meetings were well attended. He took the opportunity of thanking the colleges at Leicester, Loughborough and Derby for the facilities they have given to the Branch for conducting meetings.

No one who had attended the British Industries Fair at Birmingham and had seen the various firms from the East Midlands represented there, and the quality of the products displayed, could doubt the evidence that British manufacturers can hold their own with the manufacturers of the world.

Mr. T. H. Russell proposed the toast to "The Visitors," and in response Councillor P. Turner said that the Institute was to be congratulated on the efforts it was making to raise the standard of the education of the boy who entered the foundry. Dr. Richardson and Mr. W. H. Purnell also replied to the toast.

Mr. J. T. Driver proposed a toast to Mr. Bunting, secretary of the East Midlands Branch, who, responding, expressed his thanks for the manner in which the toast had been received.

An excellent entertainment was contributed during the evening.

Established a Hundred Years.

We are sure that the whole of the foundry industry and its suppliers will join us in offering our heartiest congratulations to Messrs. Isaac & Israel Walker, manufacturers of foundry facings and requisites, of Effingham Mills, Car House, Rotherham, on their attaining the centenary anniversary of establishment. Since 1831 this company has always been conducted by a member of the Walker family, the present head of the concern being Mr. Francis E. L. Walker. It is indeed a record of which any firm might justly be proud.

Mr. W. H. Patchell, consulting electrical and mechanical engineer, removed on Monday, March 16, from 64, Victoria Street, to 82, Victoria Street, London, S.W.1.

Dr. W. Rosenhain, F.R.S.

Dr. Walter Rosenhain, F.R.S., has resigned his position as Superintendent of the Department of Metallurgy and Metallurgical Chemistry at the National Physical Laboratory, Teddington, to take effect in June next. We understand that Dr. Rosenhain is to take up consulting work. Educated at Melbourne University and St. John's College, Cambridge, Dr. Rosenhain initiated the Department which, after nearly 25 years' work, he has made into the best-known and most famous metallurgical laboratory in the world, with a staff of 75 or 80 workers. During this period he has made many notable contributions to metallurgical research, Papers on which are to be found in the Proceedings of the Royal Society and the metallurgical institutions at home and abroad. His book on physical metallurgy is a standard work, and he has originated some remarkable advances in metallographic technique, such as the Rosenhain microscope, the plotting chronograph, the tube furnace for thermal analysis, etching reagents, etc. He is a Bessemer Medallist of the Iron and Steel Institute and a Past-President and Fellow of the Institute of Metals. He is one of the small group of metallurgists who are Fellows of the Royal Society, and a prime mover in the establishment of the new International Association for Testing Materials. Dr. Rosenhain has shown keen interest in the work of the Research Associations and is a Member of Council of both the Cast Iron and Non-Ferrous Association. His many friends throughout the industry will join in wishing him success in his new sphere of work.

Dr. Walter Rosenhain, F.R.S.

National Institute of Industrial Psychology.—According to the annual report for 1930, during the past year the membership of the Institute has increased from 1,430 to 1,600. The number of applicants for vocational guidance has increased by more than 50 per cent., compared with the number for 1929. The fees received for investigations in factories, etc., have increased from £16,400 in 1929 to £20,480 in 1930. These investigations cover a varied field, including work for railways, for firms engaged in engineering, textile machinery, etc. The Secretary's address is Aldwych House, London, W.C.2.

Testing Castings.*

By F. C. Edwards.

There is strong presumptive evidence that the natural law known as "the survival of the fittest" operates as inexorably in the evolution of industry as Charles Darwin held it to operate in the evolution of mankind. Selective agencies are constantly at work weeding out the unfit, both of the things produced and the methods of their production. Happy is that industry in which the forces of selection operate from the inside, where—to quote Herbert Spencer's definition of life—there is "a continuous adjustment of internal relations to external relations." Such industries flourish by anticipating outside requirements. They adapt, adopt and improve. They may be regarded as living organisms.

The law of the survival of the fittest applies to the foundry industry. Here we see the operation of outside selective agencies in the widespread supersession of castings by rival products. On every hand small castings are being increasingly superseded by various kinds of pressings and stampings. The medium-size cast frame is rapidly giving place to the welded-plate component. And—thanks to the ubiquitous rolled-

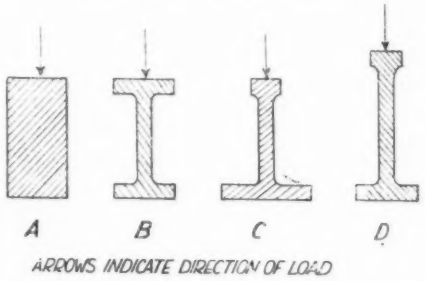


Fig. 1.—An Example of Constructive Testing.

steel section—bridge, girder and column castings are no longer required. Evidently, these sections of the industry, at least, do not conform to outside requirements. Their internal relations cannot be in harmony with external relations. It would be difficult, if not impossible, indeed, to mention any section of the industry that could be regarded as immune from the operation of this law; wherever the inside forces of selection cease to function, outside agencies will, sooner or later, bring about general extermination.

Normal Tests Inadequate.

The facts are ominous, yet, nevertheless, hopeful. The *services* formerly rendered by the replaced castings have not been superseded—they have simply been transferred. Why? Did the castings fail to pass the tests imposed? No: the foundry invariably makes good such failures free of charge. One may justifiably assume, therefore, that the castings lacked certain qualities *not covered by the usual tests* which their successful rivals possessed. This implies that the usual tests, from the foundry point of view, are not sufficiently comprehensive; for the ultimate object of testing castings unquestionably is to satisfy the customer's requirements. There is the further inference that the industry might recover much of its lost ground and prevent further inroads into its domain by adopting, as far as possible, the superior qualities of its rivals. If founders cannot initiate, well—since self-preservation is the first law of nature—they must imitate where vital improvements are concerned.

Now, what are those qualities which have enabled the newcomers to oust castings—in some cases from strongly-fortified positions? In the main, they are: lightness, neatness and reliability. And these universally acknowledged "selling points" have principally been achieved by devoting far greater attention to details of design than is usually given to the design of castings. The necessary tools for a single component may cost a thousand times that of a green-sand mould for a similar casting. This probably accounts very largely for such intensive study of design from which naturally emerge (by the operation, be it noted, of inside forces of selection) forms at once efficient and æsthetic. In other words, the desired qualities of lightness, neatness and reliability have been secured by vigorously testing the non-cast component whilst in its embryonic stage—its drawing-board existence.

Metal Testing Insufficient.

Here we have an explanation and a remedy. It is very much to be suspected that the prevailing conception of the real object of testing castings falls short of what it ought to be. In this connection, if one is to judge by the general activities of the vocal side of the industry, it is not castings, but metal that is all important. For instance, the several research associations connected with the industry appear to be almost exclusively employed in carrying out research work on metal, as metal. This is said in no deprecatory sense. The more we know of metal, indeed, the better the use we can make of it. Metal is an essential constituent of castings. But it is not the only essential. And the inevitable effect of an exclusive devotion at its shrine is a distorted perspective. The elementary, Euclidean fact that the whole is greater than the part, seems to be entirely forgotten. As a natural consequence, all eyes are focussed, and all energies are concentrated, upon one-quarter of the field of casting production. Little wonder that the industry is unable to stem the tide of the encroaching body of competitors to which reference has already been made. Castings do not exist by metal alone. Neither do they sell on metal alone. Design—and especially that design which facilitates production—is also vitally necessary.

Constructive Testing.

Now, testing the metal of which castings are composed is almost a universal practice. Testing their design is as universally rare, yet one has only to remember that a casting is an autogenous entity, self-formed by the solidification of metal in a specially-prepared mould, to realise the imperative need for such testing. With built-up structures, say, of mild steel, the draughtsman equates strength to load from definite data supplied by the producer of the ready-made sections which are to form the structures. Knowing the strength of the individual members, he is in a position to compute their collective strength, and may thus secure a very high degree of efficiency for the material employed. The designer of castings, however, does not deal with ready-made sections; he cannot ensure the strength of a casting from the summation of its parts. He may base his calculations, of course, upon definitely proved unit strength—*i.e.*, unit strength of the metal *as cast in test-bars*. But a casting is not an aggregation of test-bars. It must be viewed as a whole. It forms as a whole; it undergoes shrinkage as a whole. Both are crucial stages in casting production. And both are intrinsically connected with design. Hence, the evolution of efficient casting design necessarily involves what may be termed "constructive testing."

What is meant by "constructive testing"? For an industry to survive, it must operate, of its own initiative, the forces of selection. As is well known, castings are usually tested either by direct physical tests or by means of indirect tests. If the service conditions to which the casting will be subjected are reproduced—and intensified, of course, to give an ample margin of safety—the direct method is unchallengeable. Railway chairs are tested in this way. Cylinders are tested by direct hydraulic pressure. Castings in general, however, do not lend themselves to these simple methods. And even where the direct method is possible, it is often, for economic reasons, inexpedient. The indirect testing of a casting implies the analytical examination of its creative constituents. It may be regarded as a kind of circumstantial evidence. And, as with circumstantial evidence in general, its value is in direct ratio to its comprehensiveness and correct interpretation.

Indirect testing may prove, of course, equally as serviceable as direct testing; or it may be of doubtful value. Both tests are applied to the casting on its completion. They may be regarded as "outside" tests, since one or the other is usually specified by the outside selective agency. Constructive testing, on the other hand, has an informative value by which design may be directed into efficient and reliable channels, and production methods simplified. Constructive testing is the "inside" selective agency.

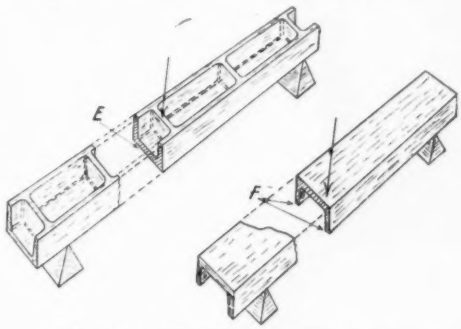


Fig. 2.—Box Girders subjected to Constructive Testing.

By constructive testing, the designer is enabled to gauge the relative strength of various forms. He proves that certain types of design give appreciably higher ratios of efficiency, weight for weight, than other types. He finds that, in some circumstances, the addition of metal actually has the effect of weakening instead of strengthening a casting; and, conversely, that the judicious removal of metal may confer extra strength. Thus, he is in a position to make the most effective use of the metal he employs—to achieve, in short, lightness, neatness and reliability.

Testing Grey-Iron Girder Sections.

Consider, now, some examples of constructive testing. It was found desirable to obtain comparative data on girder sections in grey iron. Four patterns of different sections—shown, respectively, at A, B, C, D (Fig. 1)—were employed. Two castings were made from each, all poured from the same ladle. The bars were 14 in. in length. They were tested transversely on knife-edge bearings, 12 in. apart, the load being applied at the centre of the bar in the direction of the arrows seen in Fig. 1. Bars A were of a plain rectangular section, 2 in. by 1 in. Each casting weighed 7 lbs. 14 ozs. The first bar fractured under a load of 4 tons. The second fractured at 4.41 tons. Bars B were of similar overall dimensions, but were channelled out from each side, leaving a central web ¼ in. in thickness, with ¼-in. flanges top and bottom. Each of these bars weighed 3 lbs. 6 ozs. One bar fractured under a load of 3.5 tons; the other fractured at 3.41 tons. Bars C were identical in depth with the previous ones, but the tension flange (the lower flange, as seen in the

* Paper read before the East Midlands Branch of the Institute of British Foundrymen at Derby, Mr. T. Goodwin presiding.

sketch) was increased to 1½ in. in width, and the compression flange (the top of the section, as tested) was reduced to ½ in. in width. These bars were thus of the same weight as the previous pair B—namely, 3 lbs. 6 ozs. As was to be expected from the wider tension flange, these bars gave higher stress values. One bar fractured at 3.71 tons; the other fractured at 3.86 tons. Bars D were increased in depth to 2½ in. The tension flange was reduced to 1 in. in width, and the compression flange was made ½ in. in width. Here, again, the weight of each bar was 3 lbs. 6 ozs. The test resulted in fractures at 3.79 tons and 3.80 tons respectively.

Less Metal, More Strength.

The principal feature of the above tests, of course, is the increased efficiency of the channel-section bars over the solid, rectangular bar. With a weight of but 3 lbs. 6 ozs., bars B, C and D each supported practically the same load as bars A—the weight of which was 7 lbs. 14 ozs. each. This means that a service load of, say, 10 cwts. could be as safely carried by the channelled girders as by those of the solid, rectangular section, with less—be it especially noted—than one-half of the expenditure of metal. Indeed, the channelled girders, being more immune from the possibility of porosity, etc., than the mass-section rectangular girders, could be more implicitly relied upon. The advantage gained by the lightened sections is due (1) to the removal

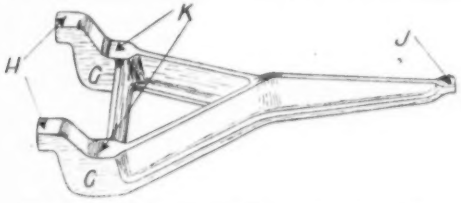


Fig. 3.—Constructive Testing applied to a Lever.

of metal from the neutral axis of the beams in B, C and D; (2) to the transference of metal in bars C from the compression to the tension side of the girder; (3) to the deepening of the beam in the case of D by transferring metal from the compression flange to the overall depth. In addition, some of the advantage gained is ascribable to metallurgical causes. These will be dealt with later.

Another significant feature of the tests is the great disparity in the results of the rectangular-bar tests as compared with the slight differences in those of the lightened sections. Thus, the difference between the respective breaking loads of the rectangular bars is 0.41 ton, against difference in the channel sections of 0.09 for bars B, 0.15 for bars C and 0.01 for bars D. The infinitesimal disparity in the results of the channelled bars seems to imply greater dependability—because greater consistency and greater regularity—in these compared with the difference shown by the solid bars.

Testing Box Girders.

Other tests were carried out on miniature box girders—seen in Fig. 2—with the object of determining the relationship between the strength of this type of component with the load applied (1) with the plated side in tension—as seen at E—and (2) with the open-ribbed side in tension—as at F. The specimens were 14 in. in length, 1½ in. in width and ⅝ in. deep. The metal was of a uniform ⅛-in. section. These bars, again, were tested on 12-in. centres. Two castings were first tested with the plated side in tension—as at E, where the arrow indicates direction of load. One fractured at 8.5 cwts., with a deflection of 0.096 in. The other fractured at 6.5 cwts., with a deflection of 0.157 in. The next pair were tested with the ribs in tension—as at F. The first specimen fractured at 3.75 cwts., with a deflection of 0.08 in. The other fractured at 4.0 cwts., with a deflection of 0.068 in.

From these tests one learns that a similarly-proportioned girder may be expected to carry twice the load with the plated side in tension than would be possible with the open-ribbed side in tension. So that, if we were designing, say, a large frame casting to carry inside mechanism, and to withstand outside pressure (of surrounding earth, subjected to heavy traffic, for example), one might secure more economic design by arranging the frame with the ribs on the outside. In this way the tension—or bursting—stress would be distributed over the full width of the plate, and the ribs would merely be required to serve as compression members.

The superiority of the channelled girder over that of solid section was partly attributable to metallurgical causes. By this is meant that the removal of the metal from what is known as the "neutral axis" of the component—economic, of course, in itself, by speeding up the rate of cooling, as well as promoting a more uniform cooling rate throughout the casting as a whole—gave a higher stress value, weight for weight, than could possibly be obtained with the "mass" section. This influence of the rate of cooling on cast metals is, of course, generally known. But it is not, perhaps, so generally realised that different mixtures of a metal, grey iron, for instance, cannot be relied upon to give correspondingly parallel stress values for respectively identical differences of section. Two mixtures, differing from each other in analysis, and cast, say, in circular-section bars of ¼ sq. in. sectional area, may be found to be practically identical in tensile strength. The same mixtures, however, when cast in circular bars of 1 sq. in. sectional area, may exhibit a difference of 20 per cent. in tensile strength. And one may ring further changes in tensile-stress value by varying the form of the bar section.

Comparison between Circular and Rectangular Bars of Grey and Steel-Mix Iron.

It may here be of interest to refer to a series of tests carried out on circular- and rectangular-section bars in different mixtures of grey iron. Tensile test-bars, 12 in. long, were cast in two forms—circular and rectangular. The rectangular bars were 2 in. by ¼ in., 2 in. by ½ in. and 2 in. by ½ in. These, of course, gave sectional areas of ¼ sq. in., ½ sq. in. and 1 sq. in. respectively. The circular bars were cast as near as possible to the dimensions which correspond to the areas of the rectangular bars, namely, 0.564 in. dia., for the ¼ sq. in. bars, 0.798 in. in dia. for the ½ sq. in. and 1.132 in. dia. for the 1 sq. in. bar. Both types of bar were cast in two different mixtures, one suitable for light general work and the other a 10 per cent. steel admixture of the following analysis respectively: Light, general, average analysis of 2 in. by 1 in. test-bar: C.C., 0.18; Gr, 3.5; Si, 3.3; Mn, 0.5; S, 0.08; and P, 1.18 per cent. Ten per cent. steel-mix iron, average analysis of 2 in. by 1 in. test-bar:—C.C., 0.45; Gr, 3.0; Si, 2.0; Mn, 0.5; S, 0.1; and P, 1.0 per cent.

Three bars of each size and composition were cast, and the average results of the test are set out in Table I.

From a comparison of these figures, it will be seen that the rectangular-section bars give higher values, unit for unit, than those of circular cross-section. The difference, again, becomes increasingly pronounced as the sectional area is reduced. In the largest section, a difference of 1 ton per sq. in. is shown. When one compares the smallest sections, however, a difference is found in their respective breaking loads of 4 tons per sq. in.

If the results of the tests on the mixture basis are compared, a difference of tensile-strength value operating in the opposite direction is found. In both circular and rectangular bars, the largest sections show a difference in the tensile strength of the two mixtures of

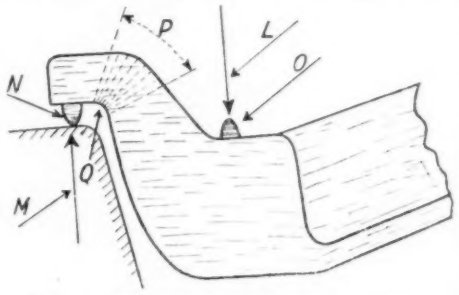


Fig. 4.—Detailing the Stresses imposed on the Feet G of Fig. 3.

3 tons per sq. in. to the advantage of the steel mix. In the smallest sections, on the other hand, the difference per sq. in. is seen to be three-quarters of a ton for the circular bars, and one and a-quarter tons in the case of the rectangular bars.

The above differences are attributable to the effect of the varying rates of cooling on the different sections and mixtures. Each successive diminution of section is accompanied by a corresponding acceleration of cooling rate, which tends to produce a finer grain structure. The rectangular bars owe their superiority of tensile strength over the circular bars, (1) to their higher cooling rate and (2) to the more uniform effect of such cooling throughout their cross-sectional plane. Here, as in Einstein's relativity problems, the time element is the determining factor. With a cross-sectional area of ¼ sq. in., the 2-in. by ⅛-in. rectangular bar has a perimeter of 4¼ in.; the same cross-sectional area in the 0.564 in. dia. circular bar has a perimeter of but 1.77 in. And the distance from

Table I.—*Relative Strength of Circular and Rectangular Bars.*

Circular Bars.

Size.	Compositions.	Breaking load in tons.	Load per sq. in. in tons.
0.564 in. diameter — ¼ sq. in.	General	4.0	16.0
0.564 in. diameter — ¼ sq. in.	10 per cent. steel mix ..	4.18	16.72
0.798 in. diameter — ½ sq. in.	General	7.1	14.2
0.798 in. diameter — ½ sq. in.	10 per cent. steel mix ..	8.3	16.6
1.132 in. diameter — 1 sq. in.	General	12.05	12.05
1.132 in. diameter — 1 sq. in.	10 per cent. steel mix ..	15.0	15.0

Rectangular Bars.

Size.	Composition.	Breaking load in tons.	Load per sq. in. in tons.
¼ in. × 2 in. — ¼ sq. in.	General	5.0	20.0
¼ in. × 2 in. — ¼ sq. in.	10 per cent. steel mix ..	5.31	21.24
¼ in. × 2 in. — ½ sq. in.	General	7.54	15.08
¼ in. × 2 in. — ½ sq. in.	10 per cent. steel mix ..	9.65	19.3
½ in. × 2 in. — 1 sq. in.	General	13.0	13.0
½ in. × 2 in. — 1 sq. in.	10 per cent. steel mix ..	16.0	16.0

the perimeter to the centre of the rectangular bar is but one-fourth that of the circular bar. Under similar mould conditions, this implies a corresponding difference in the respective radiative powers of the two bars. The metal in the rectangular bar passes through the successive stages of cooling in a shorter space of time than that occupied by the metal in the circular bar. It follows that as the operation of cooling attains a higher degree of simultaneity in all parts of the rectangular bar, the final structure of the metal achieves a correspondingly enhanced measure of homogeneity.

The noticeable approach to the vanishing point of the advantage held by the steel-mix iron in the larger sections as the sectional area becomes diminished is due, again, to the increasing influence of the temperature factor. The greater tendency to graphite growth in the high-silicon mixture over that of the lower-silicon steel-mix iron being increasingly neutralised, as with the reduction of sectional area, the rate of cooling is accentuated.

Superiority of the Triple-Bar Standard.

These tests, by the way, demonstrate the superiority of the triple-bar standard for grey-iron test-bars—as established by the British Engineering Standards Association—over the single-bar standard advocated by some of extra-national contemporaries. As will be recollected, the test-bars are designated by the initial letters "S," "M" and "L" (*i.e.*, small, medium and large), and are specified by the engineer according to the main cross-sectional thickness of the casting represented. Both transverse and tensile test-bars are circular in cross-section. The transverse test-bars have the respective diameters of:—(S) 0.875 in., (M) 1.2 in. and (L) 2.2 in. For the tensile test, the bars are turned down for a distance of 2 in. parallel at the middle of the bar respectively to:—(S) 0.564 in., (M) 0.798 in. and (L) 1.785 in.

The triple-bar standard seems to be more generally satisfying, if not actually more serviceable, than that of the single bar. For although a test-bar, strictly speaking, is but a test of the metal in the casting, and not necessarily a test of the casting itself, it does, admittedly, serve as a comparative test. Castings which differ in section differ in their cooling rates. And the rate of cooling, in turn, materially affects the strength of a casting. A test-bar may, therefore, be regarded as a more definite criterion of the strength of the casting it represents when the cooling-rate factor is common to both. This is none the less applicable, of course, when the test-bar is attached to the casting. If the test-bar must be cast as part and parcel of the casting, the portion to which it is connected should be similar in section to its own. As is well known, of course, a test-bar should be completely immune from all extraneous fluctuations, both in production and testing.

But, after all, the user of castings is normally more concerned with the strength or suitability of the actual castings than with their estimated strength as obtained from test-bars—however closely representative these may appear to be. And, since most castings are far more complicated than test-bars, the ultimate test of a casting lies beyond the province of any merely representative metal test—whether physical, chemical or micrographic.

There are at least three reasons for this. The first lies in the obvious difficulty of determining by theory the exact nature and direction of the various stresses to which a casting is likely to be subjected in service; the second is the problem of proportioning the various parts of the casting so that those stresses may safely be carried with a minimum expenditure of metal; the third (and in some cases the most tantalising factor to cope with, even by the method of trial and error) is the ever-present question of cooling or contraction strains.

Now, although a complete solution of the above problems lies in the physical testing of the actual castings, such a policy, in many cases, is completely out of the question. This is where constructive testing comes in. By means of tests on reduced facsimile models of the parts more particularly under stress, the designer is enabled to secure economic proportions for the full-size casting. In repetition work especially this practice is of the utmost value. It may, indeed, reveal a "weak link" in a vital part of the casting, which might otherwise slip unsuspectedly into service as a potential source of some future disaster.

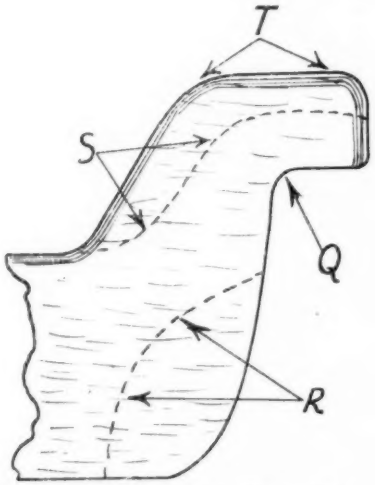


Fig. 5.—Model of Foot (Side View).

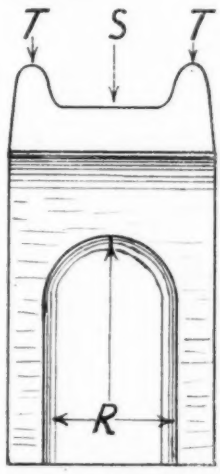


Fig. 6.—Model of Foot (End View).

A Practical Example of Constructive Testing.

It is now proposed to describe, in detail, an actual case of this kind in which constructive testing, by demonstrating the superiority of certain features, not only secured a stronger casting, but also effected a very material saving of metal. And there could be no greater tribute to the efficacy of the tests than the fact that although previously these components—subjected in service to very severe shock stress—occasionally gave way, there is, so far, no record of a single casting of the modified design having been fractured either in transport or service. And these castings, it may be observed, are used in considerable numbers in various parts of the world.

The component referred to—a triangular lever, as used in a road weighbridge—is shown in Fig. 3. It is important to note, here, that the shock stress to which these levers are liable to be subjected in service is largely concentrated on what are termed the "feet" G. An enlarged sketch of one of these "feet" is shown in Fig. 4. Now, as a first step, very helpful in constructive testing, the direction and approximately relative intensity of the stresses to be carried should be considered. Primarily the location, by analytical reasoning, of the "weak link of the chain" should be ascertained. The casting, in service, is suspended at the extreme centres H, J, on suitable knife-edge bearings (not shown in the sketch). The load is applied at K, Fig. 3. Since the distance between the centres J, K is about ten times that of H, K, the stress at J (by the law of leverages) is but one-tenth of that operating at H. Compared with the load on the "feet," therefore, the stress at the "nose end" of the casting J may safely be ignored.

The stresses on the "feet," in service, operate in the direction of the arrows L and M, Fig. 4. With the end of the lever resting on knife-edge bearing N as the fulcrum, and the load on bearing O, one can easily imagine that the casting would be most likely to fracture somewhere between the limits indicated by the arrow P, commencing at the corner—which may be termed the "tension flange" Q. Preceding rupture, the metal at the outer surface P would thus be in compression. Practice supports this theory, for fracture invariably occurs on the lines as indicated.

It should be observed that these "feet," as originally designed were cast solid, as shown in Figs. 3 and 4. The dimensions were arrived at in the ordinary way by computing the stresses it was assumed would operate, and by the application of a "safety factor," working upon a certain minimum strength for the metal. This statement does not imply any disparagement of the original design as such. One must begin somewhere. Sound casting design usually implies evolution.

Weight Reduction.

Now, keeping in mind the simple experiments on the miniature girders, and remembering how the reduction of cross-section in round and rectangular bars gave an increased unit strength, one may justifiably assume that a material increase in the strength of this component may be secured by the removal of redundant metal, especially from the compression side of the foot. The word "redundant" is used advisedly. Cast iron, of course, is considerably stronger in compression than in tension. Most of the metal located at the compression side of the foot—that is, the metal in excess of what is necessary for the support of the casting before rupture occurs at the tension flange—is not only sheer waste of metal, but by slowing up the general rate of cooling, definitely militates against the strength of the casting along the line of incipient rupture, at the corner Q, the "weak link of the chain."

Such reasoning indicated a provisional line of action to be pursued in constructive testing. In order to obtain comparative data, two half-size models of the feet were made, one solid, and the other lightened out, as shown at R and S (Figs. 5 and 6), which represent side and end views respectively of the feet. Castings were obtained from each under the same moulding conditions and poured from the same ladle. The castings were tested to breaking point, the load being applied in a similar manner to that to which the actual castings are subjected in service. The solid foot gave way under a load of 9.4 tons; the lightened foot supported 11.3 tons before fracture.

Redundant Metal.

This seeming paradox of strengthening a casting by weakening it is explained by the previous reference to redundant metal. Rupture undoubtedly starts at the corner Q. The outer flanges T are thus merely compression members. And this outer surface, although materially relieved, is still far less likely to yield under a

compressive stress than the inner surface at Q is under a tensile stress. Even though one neglects metallurgical considerations, then the removal of the metal does not militate against the strength of the foot. Regarded from a metallurgical point of view, however, an appreciable accession of strength is the expected sequence of the lighter section. These simple tests proved that the strength of a casting per unit area decreases with increase of section, or, conversely, as the sectional area is decreased, a higher unit strength is obtained. The variation is a function of the rate of cooling. In the case dealt with here, the removal of the redundant metal from the compression side of the foot—in addition to the lightening of the "body" at R, by speeding up general cooling, actually confers more than 20 per cent. increase of strength upon the "weak link of the chain" Q.

After constructive testing had given birth to a more efficient form of "foot," the feet of the working lever pattern were correspondingly modified. In addition, the "body" of the foot was cored out—as shown at U, Figs. 7 and 8 (Fig. 8 being a sectional plan on line V—W, Fig. 7). Finally, in order to reduce still further the risk of failure of the casting in service, one of the feet of an actual working lever was tested well beyond the recognised "safety-factor" limit. The maximum test load for this particular capacity lever is 20 tons. When 27 tons had been registered without any sign of fracture, the test was discontinued. The lever was subsequently passed into service.

It should here be noted that the clear gain, both in efficiency and reliability of the modified component was not vitiated by any increase of moulding cost. The top recess S (bottom as moulded) was carved out of the pattern. The front recess at R (Figs. 5 and 6) was obtained by modification of the existing "breast" corebox, the coreprint (which required no alteration) for which is seen in dotted section at X (Fig. 7). The internal core U was likewise obtained by converting the existing straight-core corebox into one of the "bottle-neck" variety.

The peculiar shape of the top of the foot in Fig. 7, compared with that of its predecessors in Figs. 3, 4 and 5, is not due to a slip of the draughtsman's pencil. It marks a still further advance in the evolution of these lever "feet." By transferring metal from the lesser-stressed "nose" at Y to the greater-stressed "back bone" at Z, the foot is enabled (with the same metal) the better to withstand the combined bending and tension stress of service loads. The weight of the metal saved by the modification amounted to ¾ cwt. per foot, or 1½ cwts. in each casting.

Routine Testing Essential.

Having described how constructive testing led to the attainment of sound and economic design, various steps for securing uniformity and reliability of production will now briefly be detailed. First, the same moulding methods as those by which the actual test casting was made are regularly practised. Then a close identity of material is maintained by daily tests. A pair of transverse test-bars are made from the same metal as that put into the castings. These bars are 42 in. by 2 in. by 1 in. Originally, it may be observed in passing, three pairs were made: one at each end and one at the middle of the cast. It was found, however, that there was no appreciable variation, so the test-bars poured at the middle of the cast were alone retained. The date of cast and the initial letter of the mixture is cast on one end of each bar. The bars are tested—usually the day after being cast—and permanent records are made. The bars are subsequently used for purposes of analysis.

The machine on which the tests are carried out is known as an "Avery No. 624 Bar Tester." The tensile tests can be made on the same machine. In the transverse tests, the test-bar is supported, but not fixed, 3 in. from each end. This, of course, on the 42-in. bar gives a span of 3 ft. between the centres. The load is applied upwards in the centre of the bar by a hand wheel at the top. It is communicated through the medium of an intermediate lever to the steelyard. Here it is "balanced off" by a poise propelled by a hand wheel at the head stock.

The weekly record of transverse tests is made out as indicated in Table II, which represents actual tests.

Table II.—*Weekly Averages of "Weighbridge" Metal.*

Breaking load (in cwts.).	Deflection (in in.).	Fracture.
35.10	0.330	Sound and close.
33.75	0.356	" "
35.50	0.383	" "
34.60	0.321	" "
34.60	0.332	" "

In addition to the above daily transverse tests, weekly tensile tests are taken. For these, the test-bars are of circular cross-section. They are cast as near as possible to 0.798 in. dia., which equals, of course, an area of ½ sq. in. This size, incidentally, simplifies the process of testing: the stress per sq. in. is obtained by doubling the load registered by the machine. Permanent records of these tests are kept for periodic examination or for the "outside" inspector's satisfaction.

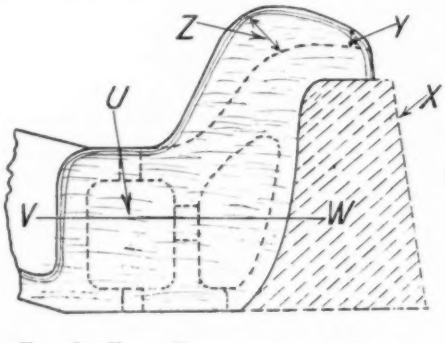


Fig. 7.—Final Design as a result of Constructive Testing.

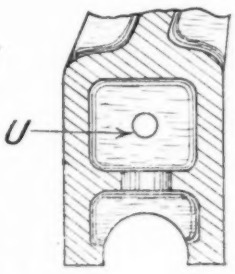


Fig. 8.—Sectional Plan at V—W of Fig. 7.

Testing the Pig-Iron.

This Paper would be incomplete if no reference were made to the testing of the pig-iron. Before a consignment of pig-iron is unloaded, it is tested as follows:—Two pigs are taken—one from each end of the truck—immediately on arrival. They are broken through the middle, and a short portion broken off. Six holes are drilled in the fractured face of the piece. The drillings are analysed the same day. If found satisfactory, the pig is unloaded and stacked according to composition and fracture.

Now although the chances are very remote of a serious drop in the quality of the metal, it is still a possibility. Herein lies the unanswerable argument for frequent testing. When any deterioration is observed, immediate steps are taken to ascertain the cause. This may be attributable, say, to a variation in the composition or in the fracture of the pig-iron, or to a falling-off in the quality of the scrap. Or, possibly, the coke contains more than its normal proportions of sulphur. Or, again, there may have been some negligence in weighing the charges. Or the weighing apparatus may need attention—a quite conceivable possibility, indeed, when one remembers the rough treatment to which these machines are usually exposed in the foundry yard. In any case, the trouble can be ascertained and remedied. Thus the founder by means of systematic testing may keep his mixtures and methods tuned up to concert pitch so as to ensure a continuous output of castings, correct—within negligible limits—to specification.

Survival of the Fittest.

This Paper began with a reference to the relationship between the foundry industry and the law of the survival of the fittest. None will deny that this relationship exists. The pertinency of associating design and methods of production with the testing of castings may, conceivably, be open to debate. In this case the author submits that, as testing implies selection, the earlier in the history of a casting that the forces of selection are put into operation the better for all concerned—particularly for the foundry. It pays, in short, to view scrap prophetically rather than historically.

All-round testing confers all-round benefits. It is the designer's *open sesame* to the attainment in castings of lightness, neatness and reliability; to the foundryman, it is a philosopher's stone, through the medium of which base metals may be converted into gold; it provides the salesman with an invulnerable selling point—reliability of product—the supermagnet for the attraction of orders in all the markets of the world; and, finally, to the foundry industry as a whole, buffeted in a relentless sea of competition, it is the sheet anchor *par excellence*.

In conclusion, the author wishes to express his sincere thanks to his employers—Messrs. W. & T. Avery, Limited, Soho, Birmingham—for their kindness in permitting him to carry out the tests to which he has referred in this Paper.

DISCUSSION.

Mr. E. Stevenson agreed with the lecturer that design was an important essential in securing good castings. He referred to serious trouble which he had experienced with certain pressure valves where the thickness of the flanges was greatly in excess of the section of metal in the body of the casting. Speaking from experience, he said he had not much faith in the efficacy of the test-bar test. As a case in point, he gave an account of a cylinder casting which the inspector rejected because its test-bar was not satisfactory. Another cylinder was accepted because its test-bar gave good results. Ultimately, however, it was found that the cylinder represented by the satisfactory test-bar "leaked like a sieve," whilst the cylinder whose test-bar failed in the test proved to be quite satisfactory. He asked Mr. Edwards to give an opinion on the question of correlating tensile to transverse test, or *vice versa*.

Mr. R. F. Orme said he was afraid mild-steel girders had come to stay, and that the foundry industry could not fight successfuily against such competition. With regard to the question of lightening castings, he had just overheard two of his colleagues denounce the idea of making castings lighter; what the foundry preferred was heavy lumps of metal, they said!

(*Concluded on page* 213.)

Some New Views on Smelting and Remelting Processes.

By J. E. Fletcher, M.I.Mech.E.

(*Continued from page* 197.)

Second Series.

The analyses of Series No. 2 of hot-blast type are given in Table XI.

The relative percentages of the two constituents, as estimated by the author's method, are shown in Table XII.

Here the alloyed constituent, when recarburised to the eutectic condition, has again a carbon content of 3.33 per cent. The analyses of

Fig. 1.—Microstructure of Upper Part of a 4 per cent. Carbon Iron. × 350.

the alloyed constituent in each grade of iron are shown in Table XIII.

The composition of the alloyed constituents, as shown in Table XIII, is indicative of the rapid increase in the manganese and phosphorus contents as the silicon content diminishes. In the No. 1 pig-iron the alloyed constituent is

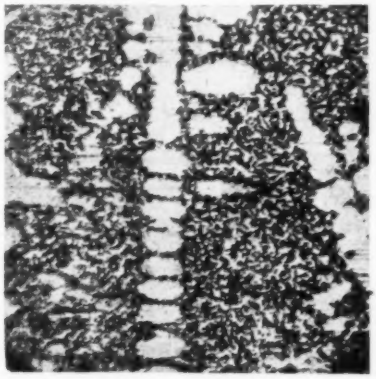


Fig. 2. — Microstructure of the Lower Portion of the Casting (Fig. 1), showing the Fine Graphite plus Ferrite Structure. × 350.

88.5 per cent. of the structure, whilst the remaining primary eutectic constituent contains 11.5 per cent. If, in the same series of pig-irons, the silicon content reached 3.96 per cent., the whole of the primary carburised sponge-iron eutectic would have disappeared, the entire structure being then that of the alloyed constituent. The silicon content of such an iron may be described as the critical silicon content of the series, any further silicon content as a result of higher hearth temperatures would result in a different type of iron structure, known commercially as "silky" or "glazy."

Incidence of "Kish."

The critical silicon content of the three series of irons is given below:—Series No. 1, 4.0; Series No. 2, 3.85; and Series No. 3, 3.96 per cent. The hearth conditions in the case of the third series must have been hotter than in the previous two, as the total-carbon contents are relatively higher, the irons Nos. 1, 2 and 3 being distinctly hyper-eutectic or of "kishy" type. This "kishy" condition is associated with hyper-eutectic pig-irons. The limiting carbon content at which a pig-iron may be expected to become "kishy" is obtained by estimating the Si as present as Fe_2Si and the P as present as Fe_3P, the sum of these two compounds or constituents (in percentages of the whole) being subtracted from 100. The difference gives the percentage of the eutectic of carbon and iron containing 4.3 per cent. carbon.

The carbon content of this eutectic portion is obtained by multiplying the eutectic portion by 0.043. Thus, in the case of a pig-iron containing Si 4.0, Mn 1.0, P 1.0 and T.C. 3.5 per cent.:—

Percentage of Fe_2Si	$= 4.0 \times 5$	$= 20.00$
„ Fe_3P	$= 1.0 \times 6.42$	$= 6.42$

The balance (73.58 per cent.) is percentage of eutectic, Mn being taken as a portion of the eutectic. The T.C. content in 73.58 per cent. of eutectic is $73.58 \times 0.043 = 3.38$ per cent. As the pig-iron has a total-carbon content of 3.5 per cent., the iron is hyper-eutectic, for it contains 0.12 per cent. carbon in excess of the true eutectic percentage. Such a pig-iron would be "kishy."

It is contended by some authorities that the silicide present is of the type FeSi, and that the expression Fe_2Si should be written as (FeSi + Fe). Estimating on this basis the eutectic condition would be found as shown below:—

Percentage of FeSi	$= 4.0 \times 3.0$	$= 12.00$
„ Fe_3P	$= 1.0 \times 6.42$	$= 6.42$
		18.42
„ eutectic	=	81.58
		100.00

Carbon content of eutectic iron is $81.58 \times 0.043 = 3.51$ per cent.

As other authorities consider that the Si is present in pig-irons as in the silicide Fe_3Si_2, the total-carbon content in the eutectic condition is then found to be intermediate between 3.38 and 3.51 per cent. (say 3.44 per cent.). The author prefers to estimate the danger point for "kishiness"—the limiting total-carbon content—by taking the Si as present in the silicide Fe_2Si. Beyond this maximum total-carbon content cast-

Table XI.—*Analyses of Series No. 2 (Hot-Blast Type).*

Pig-iron Nos.	Si.	Mn.	S.	P.	T.C.	C.C.	G.C.	Estimated T.C. in eutectic.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
No. 1	3.25	1.20	0.02	0.50	3.80	0.25	3.55	3.46
No. 3 soft ..	2.80	1.15	0.02	0.50	3.75	0.30	3.45	3.56
No. 3 medium ..	2.40	1.10	0.03	0.50	3.72	0.37	3.35	3.64
No. 3 hard ..	2.10	1.00	0.04	0.50	3.65	0.45	3.20	3.80
No. 4 soft ..	1.70	0.95	0.06	0.50	3.60	0.50	3.10	3.79
No. 4 hard ..	1.35	0.85	0.08	0.50	3.55	0.65	2.00	3.96
Mottled	0.90	0.70	0.15	0.50	3.50	1.50	2.00	3.96
White	0.50	0.60	0.25	0.50	3.30	2.80	0.50	4.04
Mean	1.88	0.94	0.08	0.50	3.61	0.85	2.76	3.75

Table XII.—*Showing the Relative Percentages of the Alloyed and Unaltered Constituents in Series No. 2.*

Pig-iron Nos.	1	2	3	4	5	6	7	8
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	3.25	2.80	2.40	2.10	1.70	1.35	0.90	0.50
Alloyed constituent ..	88.52	78.70	70.10	63.01	50.33	46.26	35.71	26.67
Unaltered primary eutectic constituent	11.48	21.30	29.90	36.99	49.67	53.74	64.29	73.33
Total carbon (eutectic) ..	3.46	3.56	3.64	3.70	3.79	3.87	3.96	4.04
Total carbon (actual) ..	3.80	3.75	3.72	3.65	3.60	3.55	3.50	3.30

Table XIII.—*Analyses of the Alloyed Constituent in each Grade of Iron.*

Pig-iron Nos.	1	3 soft	3 med.	3 hard	4 soft	4 hard	Mottled	White	Mean
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Si	3.67	3.56	3.42	3.33	3.13	2.92	2.52	2.52	3.05
Mn	1.36	1.46	1.57	1.59	1.25	1.83	1.96	2.25	1.72
P	0.56	0.64	0.71	0.78	0.92	1.08	1.40	1.87	1.00
C	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33

ing troubles may be expected. It has long been known that the mechanical properties of cast iron are improved by lowering the total-carbon content below the percentage corresponding to the eutectic condition.

Pig-irons which are dominantly hypo-eutectic are a vital necessity, and it may be definitely stated that the index to the quality of a pig-iron of desired Si, Mn and P contents is the carbon percentage below that which, as estimated above, corresponds to the truly eutectic condition. In the three series of pig-irons examined, the analyses of which are given in Tables II, VIII and XI, the cold-blast irons are definitely more strongly hypo-eutectic than either the warm-blast or hot-blast irons. The lower-silicon pig-irons are produced under lower hearth temperatures than the higher-silicon irons, and, as a consequence, the total-carbon contents are lower. It has been shown, however, in the case of the cold-blast charcoal irons of Table I that the richness of the ores (high iron content) has a strong influence on the carbon content.

High-Silicon Pig-Irons.

This is seen in hematite irons which are produced from rich ores, where the total-carbon contents often reach 4.0 per cent. and above in the

higher-silicon grades (up to the critical Si content estimated by the two-constituent method). Above this critical content the total-carbon content falls until, with a ferro-silicon (produced in the blast furnace) of, say, 12 per cent. Si content, the total-carbon content is about 1.8 per cent. A eutectic pig-iron of 12 per cent. Si content should have a total-carbon content of between 1.7 per cent. (when Si is taken as present in Fe_2Si) and 2.75 per cent. (when Si is assumed as present in the silicide FeSi). The author has found such ferro-silicons (11 to 13 per cent. Si) to be "kishy" with total-carbon contents of 2.0 per cent.—suggesting that the Fe_2Si basis is the safer one to work with.

The two-constituent theory shows that the two constituents are present in the molten metal up to the point where the critical Si content is reached—when all the carbon in the primary carburised sponge iron of eutectic analysis has been used up in the alloying reactions—the metal being then of one single constituent containing the Fe, Si, Mn, S and P. Before further Si can be alloyed the single constituent must be recarburised, after which the alloying reactions can proceed afresh. It is significant that when the critical Si content is reached the higher-Si irons become markedly different in character until the point is reached where the blast-furnace method is incapable of yielding a higher-Si content. Theoretically, if the Si is present as Fe_2Si the limiting Si content in a blast-furnace product would be 20.0 per cent.

Mr. T. E. Holgate, of the Darwen & Mostyn Company, reported a ferro-silicon of 17.8 per cent. Si, the total-carbon content of which was 0.66 per cent. The alloying of the molten carburised-sponge iron (assumed to be of 4.3 per cent. carbon content) during the manufacture of high-Si pig-irons (ferro-silicon type) may be interpreted in the light of the two-constituent theory. It has been shown that the critical Si content corresponding to the alloying product when all the carbon primarily present in the sponge iron (carburised to 4.3 per cent. C) can be readily estimated. In pig-iron containing 1.0 per cent. Mn and 0.05 per cent. P this is found to be 4.20 per cent. Si, with a total-carbon content of 3.33 per cent. when the iron is of eutectic composition.

The eutectic content of this iron is 76.7 per cent. The Mn is separately present at 1.07 per cent. Mn_3C. Now 76.7 lbs. of eutectic is sufficient for the alloying of 76.7/19.93 = 3.85 lbs. Si. When this occurs a second Si critical point is reached, the analysis of the metal being:—

Si	4.39 + 3.85 = 8.24	per cent.
Mn	1.00	,,
P	0.05	,,
C	2.56	,,
Fe and S (by difference)	88.15	,,

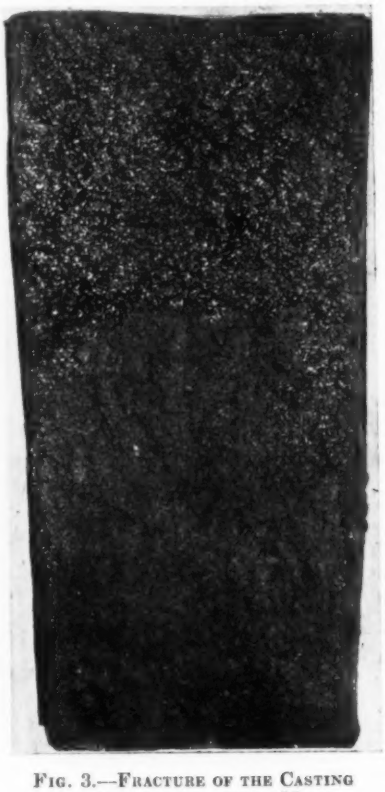


Fig. 3.—Fracture of the Casting from which the Micros. (Figs. 1 and 2) were taken.

The above is based on the assumption that no further Mn or P is alloyed along with the Si. In practice this is not the case, though it is found that the pick-up of Mn and P in the higher-Si pig-irons or ferro-silicons proceeds more slowly as the silicon content is increased. Thus, in practice the P content in 8 per cent. Si pig is often in the region of 0.05 per cent., 0.08 per cent. in 14 per cent. Si pig, and 0.10 per cent. in 16 per cent. Si pig-iron. There is considerable oxidation in the hot hearths of furnaces making ferro-silicon, and, whilst with the same ore burden there should be a gradual increase in the Mn contents in the pig-iron as the silicon percentage increases, there are unavoidable variations in the Mn content, the range being between 1 and 3 per cent.

At the second silicon critical point the analysis (allowing for the same ratio of Si, Mn and P increase as occurred during the smelting of the 4.39 per cent. Si pig) will have the following corrected values: Si, 7.65; Mn, 1.74; P, 0.09, and C, 2.56 per cent. In practice the increase in the Mn contents corresponding to the increase in Si per cent. varies with the analysis of the ore burden, the Mn losses during smelting being variable and differing with the size of furnace and rate of driving. The 10 to 14 per cent. ferro-silicons often give Mn and T.C. contents of 2.0/2.5 Mn and 1.6/1.9 per cent. T.C. respectively.

The Si critical points occur approximately at the following values:—

	1st.	2nd.	3rd.	4th.	5th.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Si ..	4.2	7.7	10.5	12.2	14.3
T.C. ..	3.3	2.6	2.0	1.7	1.5

It must, of course, be recognised that during the alloying of the sponge-iron eutectic, during

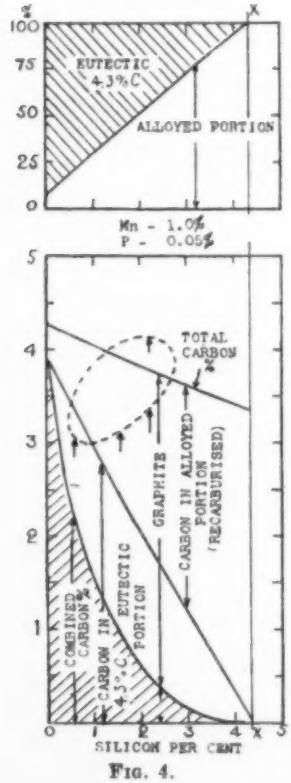


Fig. 4.

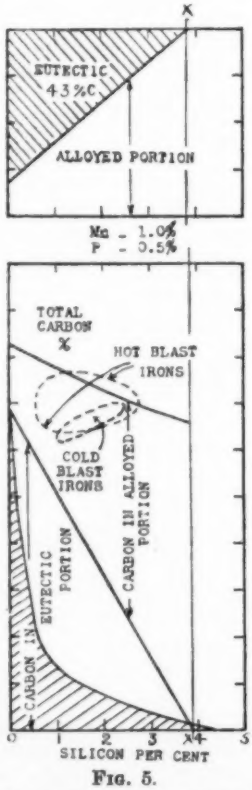


Fig. 5.

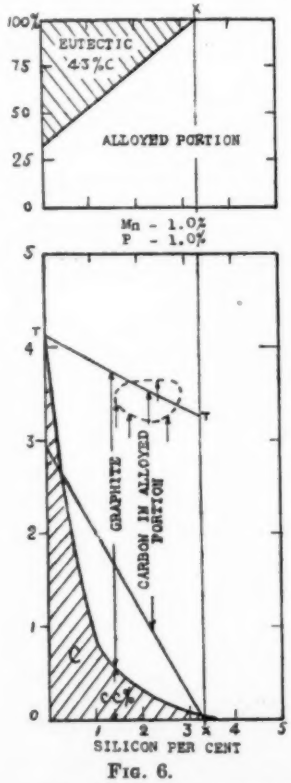


Fig. 6.

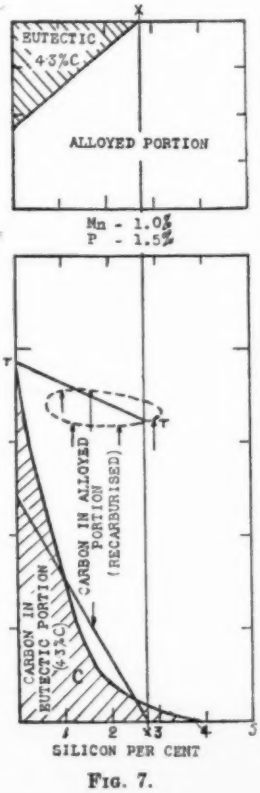


Fig. 7.

Figs. 4 to 7 are diagrams of irons containing 1 per cent. Mn with increasing P content.

which the primary carbon is liberated in the CO gas, there will be simultaneously a recarburising of the liberated Fe. In the estimate of the alloy at the first critical point the recarburisation is assumed to have re-formed the 4.3 per cent. carbon eutectic which then exists side by side with the Fe_2Si, Mn_3C and Fe_3P forming the balance of the structure. The 3.3 per cent. carbon in the first critical Si alloyed iron is used in the further alloying of Si, Mn and P resulting in the second critical alloy of 7.7 per cent. Si content. The 2.6 per cent. carbon in this second critical alloy is due again to the re-carburisation of the liberated Fe.

A sequence of such estimated results leads to the theoretically final alloy containing about 20 per cent. silicon which is carbon-free. The rational conclusion arrived at is confirmed by the estimated total-carbon contents in each of the critical alloys, these carbon contents agreeing very closely with those obtained in the ferro-silicons in commercial use. It should be pointed out, however, that, as Gontermann has shown, it is possible to produce alloy irons of high-silicon contents containing much higher carbon percentages, and there are ferro-silicons available (blast-furnace smelted) of about 13 per cent. silicon content which contain over 3.5 per cent. total carbon, such alloys being of "kishy" character.

Combined-Carbon Contents in Pig-Irons.

The two-constituent method has made it possible to estimate the expected combined carbon in pig-irons. It will have been noticed that the alloyed constituents of grey irons containing more than 1.0 per cent. Si are high in silicon content, the analysis of the alloyed constituent being similar to pig-irons which, during cooling from the molten state, have their carbon almost completely graphitised. The author has found that the remaining eutectic constituent, containing 4.3 per cent. carbon, may be taken as cooling to the pearlitic condition.

When this eutectic cools to the pearlitic condition, the combined carbon in the pearlite is 0.87 per cent., and, if the estimated percentage of the remanent carbon-iron eutectic constituent (as estimated from the analysis of the pig-iron) is multiplied by 0.0087, the combined-carbon content to be expected in the pig-iron is determinable. The author has compared a large number of representative British pig-iron analyses, and has interpreted these analyses in the light of the two-constituent theory. From the eutectic constituent percentage thus estimated it has been possible to determine the expected combined-carbon contents in each case.

The results are closely in conformity with the combined-carbon contents obtained by actual analysis. In the case of mottled and white irons, the conditions of manufacture are abnormal, as the blast-furnace hearth temperatures are low and in most cases accompanied by low blast temperatures. In most of the low-silicon irons the alloyed constituent, which occupies only a small portion of the whole, is high in manganese and phosphorus contents, corresponding to a hard pig-iron rich in the carbides of Fe and Mn, the phosphorus being present in the hard ternary, C, Fe, P eutectic.

Graphitic-Carbon Contents in Pig-Irons.

When the remanent carbon-iron eutectic constituent is graphitised to the pearlitic condition, the composition is as follows:—Graphitic carbon, 3.43; combined carbon, 0.87; and Fe, 95.70 per cent. The author, by cooling a ½-in. dia. bar of red-hot approximately eutectic iron (4.0 per cent. C, 0.5 per cent. Si and 95.5 per cent. Fe), in a heavy mass of molten cast iron (which was allowed to cool very slowly to the solidification point), obtained the pearlitic condition in the structure of the small bar. The graphite flakes were of fine and small character, and there were some small specks of nodular graphite present.

By subjecting similar bars of composition typical of the alloyed constituents in grey irons, the slowly-cooled structure was practically free from combined carbon, being almost entirely graphitic. The graphite flakes in this case were of large size and generally of straight-line form, but not so massive nor so straight as found in the actual pig-irons from which the small bars were cast. The deductions to be made from these experiments are that one may expect the graphite forming from the two constituents to be of fine form and well distributed in the case of the eutectic constituent and of massive flake form in that of the alloyed constituent.

The photomicrographs, together with a view of the fracture structure (Figs. 1, 2 and 3), represent the results of an earlier experiment of Prof. E. Heyn.

The chemical analysis of this iron was: T.C., 3.56; C.C., 0.14; Gr, 3.42; Si, 3.30; Mn, 0.94; S, 0.06, and P, 0.09 per cent. The small ingot was cast in a sand mould having a thick iron bottom-plate, which formed a chill.

Fig. 1 shows the structure in the upper half of the casting and Fig. 2 that in the lower half, whilst the photograph of the fracture (Fig. 3) shows very clearly the result of the chilling action. The metal in question may be taken as being composed of the author's two constituents, having the following analysis:—

4.3 *per cent. carbon-eutectic constituent:*

Analysis of eutectic constituent.

T.C. content	4.3 per cent.	}	21.4 per cent. of whole.
C.C.	,, 0.87 ,,		
Gr	,, 3.43 ,,		
Fe	95.70 ,,		

Alloyed constituent.

T.C. content	3.36 per cent.	}	78.6 per cent. of whole.
Si	,, 4.24 ,,		
Mn	,, 1.21 ,,		
P	0.11 ,,		

The fine graphite + ferrite structure (Fig. 2) is similar to that described by Hanemann, Schuz and other metallurgists, and more recently by Dr. A. L. Norbury, of the British Cast Iron Research Association. The coarsely-graphitic structure (Fig. 1) is typical of the slowly-cooled cast iron of the analysis given and would be seen on a micro-examination of the pig-irons of this analysis.

Structure of Pig-Iron.

It will be seen from the foregoing notes that the two-constituent method of analysis furnishes new and useful information on the birth and growth of the crystalline structure of pig-iron. The application of the method to four distinct groups of pig-irons is illustrated in Figs. 4, 5, 6 and 7. The graphed results of the estimated proportions of the two constituents in the four groups are shown in the upper diagrams plotted in relation to the silicon contents.

In Fig. 4 the pig-irons depicted are of the 1.0 per cent. Mn, 0.05 per cent. P class.
In Fig. 5 the pig-irons depicted are of the 1.0 per cent. Mn, 0.50 per cent. P class.
In Fig. 6 the pig-irons depicted are of the 1.0 per cent. Mn, 1.00 per cent. P class.
In Fig. 7 the pig-irons depicted are of the 1.0 per cent. Mn, 1.50 per cent. P class.

In the lower diagrams the combined-carbon contents in the pig-irons are shown by the curved lines above the hatched areas. The vertical lines **X X** in each graph indicate the Si content at the critical Si content when the whole of the carbon in the primary carburised sponge-iron (eutectic) constituent has been used in the alloying reactions. The dotted loops crossing the total-carbon lines indicate the variation in actual total-carbon contents in the commercial range of pig-irons of each group. In Fig. 5 the small lower loop shows the hypo-eutectic character of the cold-blast irons, the actual variations in total-carbon content being small. The hatched portion in the upper diagrams marked "eutectic 4.3 per cent. C" represents the case of pig-irons of truly eutectic character, where the unaltered eutectic constituent consists only of the 4.3 per cent. carbon-iron eutectic. It has been explained in the Paper that in some cases this constituent is hypo-eutectic in character and, in the case of some hematite irons, is occasionally hyper-eutectic.

(To be concluded.)

Testing Castings.

(Concluded from page 210.)

Mr. J. C. Hallamore said that, although he recognised the importance of securing good design, it was only the larger shops that could to carry out experiments. The small shop had a great variety of work to deal with, mostly one-off jobs.

Mr. P. A. Russell considered that, as a casting was designed to suit some specific purpose, the business of the foundry was to produce whatever was demanded. They could not expect the engineer to shape his castings merely to suit the convenience of the foundry. He held that the test-bar, with all its shortcomings, still rendered very useful service.

Author's Reply.

In reply to Mr. Stevenson's question, Mr. Edwards said that, in his opinion, unless one were dealing with identical mixtures, melting and casting, etc., the attempt to correlate tensile with transverse test figures, or *vice versa*, was very hazardous.

With regard to Mr. Orme's remark that the foundry preferred heavy lumps of metal, the author replied that this was a short-sighted policy; every casting that proved unsatisfactory in service was a bad advertisement for the foundry. He was not sure, again, that the foundry was wise in meekly accepting the dictum that mild-steel girders should have even this field to themselves; it was mostly a question of suitable design. He quoted a case where castings (steel) had replaced with success mild-steel girders for the frames of locomotives.

Replying to Mr. Russell, the lecturer said that the usual foundry attitude of acquiescence in what ever design it was asked to reproduce was fundamentally wrong in principle. Incidentally, it had the baneful effect of perpetuating bad casting design. As a consequence, the foundry was heavily handicapped compared with its most deadly rivals, who insisted upon suitable design from their own production point of view.

Mr. C. W. Bigg, in proposing a hearty vote of thanks to the lecturer for his excellent Paper, said that he would like to see the sketches with which the Paper was illustrated hung on the wall of every drawing office in the country. He suggested the employment of Mr. Edwards as a missionary, preaching the foundry point of view in these matters to engineers and draughtsmen generally.

Mr. Orme seconded the vote of thanks, which was carried with applause.

Air Discharge of Circular Tuyeres.—A Paper by Richard S. McCaffery and Daniel E. Krause, in Technical Publication No. 385, issued by the American Institute of Mining and Metallurgical Engineers, describes a laboratory method of testing the efficiency of blast-furnace tuyeres with a view to developing improved design. It includes a short discussion of the conditions in a modern blast furnace and the possibilities of improving these conditions by using a different type of tuyere. The shapes of the air streams from various types of tuyeres were determined, and some of these shapes are illustrated, together with a description of the apparatus used.

The Use of Block Patterns and Cores.

MODERN MOULDING METHODS OUTLINED.

A meeting of the London Branch of the Institute of British Foundrymen was held in the studios of Messrs. Edibell Sound Film Apparatus, Limited, 89, Wardour Street, London, W.1, on Thursday, February 19, 1931, the Branch-President (Mr. A. F. Gibbs) in the chair.

Moulding a Machine Base.

A Paper on the subject of "Moulding a Machine Base" was read by Mr. J. Bennett (Stroud). This Paper has been published in The Foundry Trade Journal for May 1, 1930, page 330.

After dealing with the moulding of this particular machine base, Mr. Bennett illustrated and discussed a number of other castings which

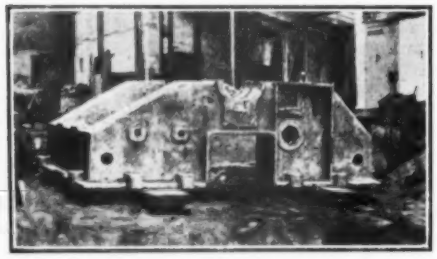


Fig. 1.—An Unfettled Machine Base, weighing 28 cwts.

had been produced at his works. Fig. 1 illustrates another machine base in the condition in which it came out of the sand, and before the fettlers had touched it. The pattern was made of block section. The pattern maker, said Mr. Bennett, had wished to make a skeleton pattern and lift the cores out from the inside, about 3 ft. deep, and then get underneath the top box and finish it. He (Mr. Bennett) had not agreed to that course, however, and eventually the block pattern was made; six or seven castings had been made from that pattern, which re-

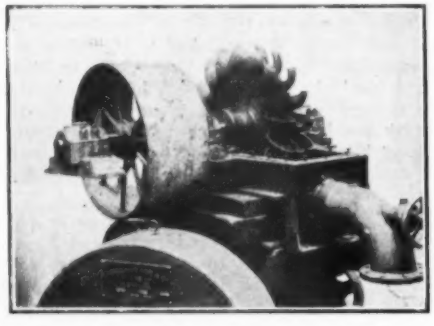


Fig. 2.—A Pelton Wheel with Cast-on Buckets.

mained in as good a condition as it was originally. It was about $\frac{3}{8}$ in. thick all round, inside and outside. They had made dry-sand cores, then made the mould, and finished and dried it, then made slabs of well-tempered clay, put them in the bottom of the mould, and lowered the cores in and fixed them in position. Then they had put the top box on and had bolted the cores to the top. The job, with the cores hanging from the top box, weighed about 8 tons. If the suggestion made originally by the pattern maker had been adopted there would not have been much to hold the pattern together; at any rate, it would have been a very slender pattern, and would not have been as good as in fact it was. A second casting, shown in Fig. 2, referred to a Pelton wheel made in the same foundry. Describing the making of it, Mr. Bennett said that originally it was the practice to make a circular disc, which was machined up; the buckets had ears on them, and were machined in between and bolted up. Then it was decided that the buckets had to be cast on—and this was quite simple. The only disadvantage was that at the centre the cores were not very thick—not more than about $\frac{1}{4}$-in. A wedge-shaped box was made and the bucket placed in the bottom of the box, and then they obtained the impression of the back side of the bucket. On the other side of the box were printed the cores of the inside of the bucket. So that there were wedge-shaped cores pointing to the centre of the job, on edge. There was very little trouble in balancing, and considerable saving was effected in machining. Fig. 3 illustrates a rotor for a turbine, the making of which was one of the most difficult jobs he had tackled. The casting, in its rough state, weighed about 35 cwts. The blades were of steel, cast into a rim on the bottom side and a conical-shaped plate at the top side. It was quite difficult to get the blades into position. For setting the blades he had had a flat cast-iron rim with saw-tooth notches in the bottom, into which the blades were fixed, and in that way they were

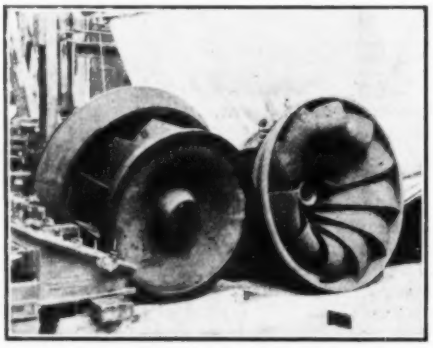


Fig. 3.—A Turbine Rotor which proved a Difficult Job.

spaced equally; then a spindle and strickle were used, and the sides of the blades were set upright with a hanging strickle. About 1 ton of metal had to be run through them to get them to burn-on to the steel blades. About 1 in. was cut off the top edge of the rim, which was machined, and if he had not put as much as 1 in. on he would have experienced trouble; it had just cleaned up. A great cavity was blown, presumably through so much wrought iron being in the job. However, he had put some risers on, poured plenty of hot metal round, and eventually had made a very good job of it.

DISCUSSION.

The Branch-President, after expressing indebtedness to Mr. Bennett for his very practical Paper, said that whilst he had been extremely interested in the description of the making of the machine base referred to, he would have liked to have heard something also with regard to the melting processes, sand mixing, and so on. With regard to the pouring, he said he had not noticed the runner, and he asked if the castings were bottom poured.

Mr. Bennett said the down runner was shown in the end core; of course, it was necessary to connect the two, when the core was in position, with the down runner at the top.

The Branch-President expressed surprise that Mr. Bennett had not fixed the bottom core with the two end cores. There was a possibility of metal getting under the bottom core, though, no doubt, it was well stopped in round the print. Sometimes a scab occurred at the bottom, and the metal was likely to get under the core and lift it; he would be inclined to use a grain or chaplet in each end, between the two end cores and the bottom core, to prevent lifting.

Loam or Oil Sand.

Mr. F. J. Cree asked Mr. Bennett how he had located the top part.

Mr. Bennett said that when the two lightening cores were in there was a perfectly plain top. They had rammed up a plain top on a sand bed and had lowered the top part into position; when it was in position they had driven stakes into the floor, so that they were certain to get it back into the same place again.

Mr. Cree, who said that he was adopting the same practice, asked Mr. Bennett what his cores were made of.

Mr. Bennett replied that they were made of loam sand.

Mr. Cree suggested that the cores would have been made much more quickly if a compound oil sand had been used.

Mr. Bennett said that possibly that would have been the case, but at his foundry they did not use oil sand, except for internal cores; they regarded it as being more expensive than loam sand.

Mr. Cree did not consider that oil sand was so expensive as was sometimes believed to be the case.

Mr. Grant (Rochester) asked what were the ingredients of the blacking used on the cores.

Mr. Bennett said he had used a charcoal blacking mixed with clay wash.

Mr. W. H. Aston asked for information as to the size and weight of the machine base described, and also with regard to the cost.

Mr. Bennett replied that he had not the actual figures of cost at hand, but it was quite a reasonable figure per cwt. The weight was about 28 cwts. The casting was 6 ft. or 6 ft. 6 in. long; whilst the moulding boxes, in three parts, had the job been made from a whole pattern, would have measured 10 ft. long, 6 ft. wide and 4 ft. deep.

Turbine Rotors.

Mr. A. R. Bartlett (Past-President of the London Branch), as one who had had considerable experience of turbine work, was particularly interested in the turbine rotor illustrated by Mr. Bennett, and said he appreciated Mr. Bennett's difficulties in running the metal round the blading in such a manner that it adhered properly. Commenting upon Mr. Bennett's statement that he had had to flow about 1 ton of metal through, he said that he also had found it necessary to run a certain amount of metal through, and also to allow for a reasonable amount of tooling on top, to counteract any trouble due to blowing, or anything of that description. Further, he had found that it was imperative to cast at a definite temperature; if the metal were too hot it was likely to burn the blading away, and if it were too dull one did not secure proper adhesion between the cast iron and the blading. When it was remembered that such parts of turbines had to run at speeds of not less than 3,000 r.p.m., it would be appreciated that they had to withstand a very great amount of force due to the steam passing the blading, so that trouble would arise if the blades were not securely fixed.

Mr. Bartlett agreed with Mr. Bennett that the use of cores was the best practice for making castings of a description such as the machine base dealt with in the Paper. Judging from a model which had been exhibited, he said he imagined that the side ribs of the casting were about 1 ft. deep.

Mr. Bennett agreed.

Oil-Sand Cores.

Mr. Bartlett said it was impossible, of course, to draw 1 ft. of pattern in and finish 1 ft. back, in a rib which was only 1 in. thick, if there were any fault, and it was essential that the job should be made with cores. Another advantage of the use of cores was that the work could be spread out between two or three men, each having two or three core boxes, so that one could ensure quick delivery—a very important factor in the securing of a contract. With regard to the running, he said that Mr. Bennett had run the casting at one end only, but pointed out that if the casting had been much larger it would have been necessary to have run it from two ends. It also appeared to him that the core irons were very heavy indeed for such a casting, in view of the amount of contraction that occurred inside. He expressed agreement with Mr. Cree that the work could have been carried out more quickly if oil-sand cores had been used, both for the inside and the outside, but especially for the inside, because they would have eased themselves much more quickly than hard loam sand cores. Commenting upon the Branch-President's reference to the provision of an anchorage to the centre core, he said that he personally would not consider it satisfactory to fasten a core by just ramming 1 in. of sand round the base, and, from the point of view of safety, he would certainly prepare an anchorage under the job, such as on the foundation grid, and put a bolt from the surface of the core to the foundation grid so arranged. The initial cost of a pattern for a casting of the kind described would have been expensive, and there was the difficulty, not only of moulding the job, but also of keeping all the parts in place, which was another argument in favour of making it with cores. It seemed to him that the problem of contraction was not taken fully into consideration, and he suggested that it would have been advantageous to have used a softer core. As to the suggestion that oil-sand cores would have been costly, he said that the initial expense of the core sand and the oil might have been greater than that of the sand actually used, but, bearing in mind that one could make cores of that kind with 50 or 60 parts of sand to one part of oil, he did not think the proposition would have been very expensive on the whole, for the core makers could make them more quickly and cheaply with oil-sand cores. He had carried out a good deal of work, using segmental cores, but the difficulty had been to get them placed accurately and to ensure that they did not move. The method of bolting the two side cores together made it impossible for any spread to occur in that direction, and he gathered that the cores at the other end were packed.

Mr. Bennett said he had packed them behind the bolts.

Ensuring Adhesion between Blades and Iron.

The Branch-President, referring to the turbine casting which Mr. Bennett had illustrated, asked if any painting medium were used on the steel blades to assist adhesion, and, if so, what that medium was.

Mr. Bennett replied that when the castings were originally made he used red lead, but if he were doing the job again he would tin the blades; he would certainly advise tinning.

Mr. Bartlett, as one who had used red lead and tinning, disagreed with Mr. Bennett's advocacy of tinning the blades, and said that it was too expensive, bearing in mind the cost of the tin and of the labour entailed in putting it on. The material, he said, came to the foundry in a fairly bright condition, and it was allowed to attain a fine rust. Thanks to the work of the scientists, he had discovered that sodium silicate acted as a flux to iron oxide. The blades were held in cores, and the protruding part was covered with a very fine coating of sodium silicate mixed with warm water. To those unfamiliar with the term sodium silicate, he mentioned that its common appellation was water glass, the material used by poultry-keepers for preserving eggs. It was quite cheap. When the hot metal came into contact with it, it acted as a flux and took off the rust, so that there was clean metal for the cast iron to run against, and thus there was proper fusion with the steel blading. If tin were used it would float, and would give rise to a certain amount of dross on the top of the casting. Also, red lead gave rise to a certain amount of disturbance when the metal came against it.

All-Core Moulds.

Mr. Wesley Lambert (Past-President of the Institute), in offering his personal thanks to the lecturer for his Paper, expressed disappointment that a greater number of practical foundrymen had not taken part in the discussion, either by way of challenging Mr. Bennett's method of making the machine base he had described, or complimenting him upon adopting a cheap and very satisfactory method. He would have liked to have heard from them as to whether or not it was a recognised practice in the foundry trade to build up moulds for such parts with cores on the manner adopted by Mr. Bennett. Referring to a fairly large casting to which his attention had been directed a short time ago, Mr. Lambert said he had been told by the foundry proprietor concerned with that particular type of casting that it was his practice to build up the mould entirely with cores, of which seven or eight were used. Mr. Lambert added that consideration of the cost of the core boxes—they were made of hard mahogany—and the cost of making the cores, stoving, etc., would lead one to the conclusion that unless the labour employed was very cheap this method of making the casting in question was not an economic one. He asked if all the cores used by Mr. Bennett were stoved?

Mr. Bennett replied that they were.

Mr. Lambert added that, in his opinion, Mr. Bennett deserved very great credit for having turned out a set of castings of the size of the machine base he had described—free from blow-holes and other defects—in a foundry in which only light lifting tackle, etc., was available.

Core Moulds Accelerate Delivery.

Mr. Bartlett pointed out that he had expressed the view that the method employed by Mr. Bennett was the best method, and that he personally would not think of making the casting in any other way. He mentioned some castings turned out at his foundry, each weighing 20 tons, and which could not have been made except by the use of core boxes and the building up of the mould by placing the cores. Mortars for milling work, weighing 6 tons apiece, were also turned out at his foundry at the rate of two per day, and they were made by the use of cores. That was the best way of doing the job. Further, he considered that the making of the cores and core boxes would be cheaper than the making of a pattern of intricate design for a casting such as that described by Mr. Bennett, and that the use of the segmental method enabled one to produce the castings and ensure delivery more quickly. He added that he had turned out castings weighing 20 tons at the rate of one per day by spreading the core-making among a number of core makers, and employing only two men to assembled the moulds. Of course, the tackle used was made for such work, so that it was simplified as far as possible.

A speaker, who had been concerned with the making of castings similar to the machine base described by Mr. Bennett, said that it was quite a simple matter to assemble the cores, and that a lad with only three years' training could put the mould together in seven hours. The method adopted was very similar to that adopted by Mr. Bennett. The speaker expressed the opinion, however, that the core irons used by Mr. Bennett were rather too heavy, and that such heavy core irons would not have been needed if an oil compound sand had been used. He would advise any who were concerned with work of this nature to try a compound sand. From the point of view of contraction its use would be very much better.

The Branch-President said that possibly Mr. Bennett had made allowance for contraction in the sand. It was not essential to use an oil compound; before the introduction of oil compounds steps had had to be taken to allow for contraction, and he imagined that Mr. Bennett in this case had used some opening material in his sand.

Core Grids and Contraction.

Mr. Watts asked if Mr. Bennett had bolted down the top, or whether he had merely weighted it.

Mr. Bennett replied that he had bolted it; he had some girders, and a grid in the bottom. He had made six such castings, and in none of them was there any sign of a crack or other defect due to the grids being too strong or to any other factor of that sort. He was a firm believer in the use of a strong grid. One of the cores was quite 10 ft. long, and he wanted to avoid the springing and cracking of the cores when they were lifted about. In his opinion, if the grid were small enough to allow for contraction, one need not trouble about the strength of it, and indeed, he had not experienced the slightest trouble due to contraction. With regard to the bolting of the core, he confessed that at first he had had doubts as to whether or not he should bolt it down. Of course, if there were any scabbing, and if the metal did get under the core, the core would be lifted. Chaplets could be placed in the circular part, but he did not think they would be sufficiently strong to be of much use if the core once started to lift. As the result of his experience, however, he would make similar castings in the future by the same methods as he had adopted in this case. The core was quite heavy, weighing about 1 ton, and unless the metal got under it there was no lift. The sides were plain, and, when the mould began to fill, the metal was on top of the core.

Mr. Carroll, discussing the machine base, said he was inclined to the view that it was possible to make it by a cheaper method than that adopted by Mr. Bennett. His suggestion was that if it were turned on its side one could do away with the side cores and still have a block pattern, and if oil-sand cores were used much time could be saved. The time of the men in the foundry and the core makers would be saved by adopting the method he had suggested.

Mr. Perry, whilst he believed that Mr. Bennett would have benefited by using oil-sand cores—because the making of oil-sand cores was practically an unskilled job, and also because the cores would dry more quickly and in general would produce a better job—disagreed entirely with Mr. Carroll's suggested method of making the casting, and said that the ramming would entail a good deal of skill.

Mr. Bennett also disagreed with the suggestion made by Mr. Carroll, and said that that method was the very last he would adopt for making such a casting.

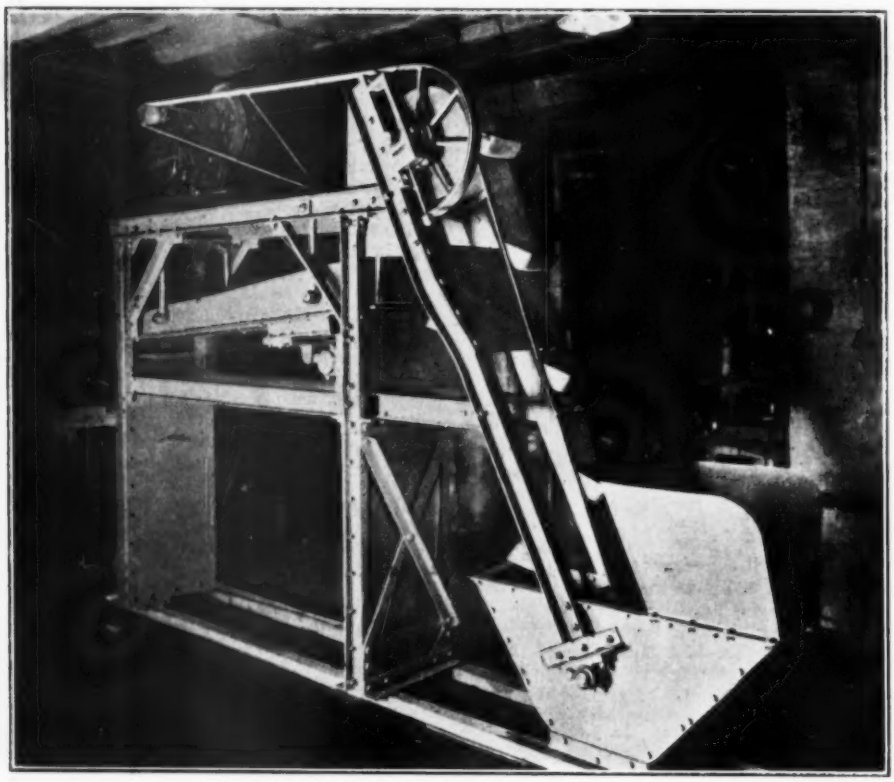
Vote of Thanks.

Mr. W. B. Lake (Hon. Treasurer of the Institute, and Past-President of the London Branch), proposing a hearty vote of thanks to Mr. Bennett for his Paper, complimented him upon the very clear manner in which he had described the making of the casting, and added that it was evident, from the opinions expressed by those well qualified to speak, that Mr. Bennett had made the casting in the right way. After all, the photographs of the castings spoke for themselves, and Mr. Bennett had triumphantly refuted all criticism of his methods. Some speakers had considered that he might have done better by using oil sand rather than the mixtures he had used, but that had to be proved, and the actual cores were as perfect as they were likely to be made in any other way.

Electro-Magnetic Belt-Bucket Elevator Separator.

Though it is but a few weeks since we published an exhaustive Paper, by Mr. W. E. Box, on the subject of the "Magnetic Treatment of Moulding Sands," yet since that time there has been an entirely new and simple development by his firm, the Rapid Magnetting Machine Company, Limited, of Lombard Street, Birmingham.

As will be seen from our illustration, a magnetic pulley has been substituted for an ordinary head pulley in a belt-bucket elevator. As each bucket passes over the magnetic pulley it becomes magnetised and returns any tramp iron, whilst the uncontaminated moulding sand falls on to a jig-shaker screen for either removing the fines or returning the lumps, the iron being dropped into a suitable receptacle. One would hardly believe that such a simple idea had not previously been protected, but we are assured that the conception is truly novel and that patents are being applied for. Obviously, if sufficient headroom be available, it would be a simple matter to convert many existing plants.



The New Electro-Magnetic Belt-Bucket Elevator Separator developed by the Rapid Magnetting Machine Company, Limited, of Birmingham.

X-Ray Examination of Steel.—Mr. J. Jefferson, in the course of "Some Notes on Steel Castings," recently read before the Institution of Engineers and Shipbuilders in Scotland, mentioned the fact that Dr. V. E. Pullin, at the Royal Arsenal, Woolwich, has been able to produce X-rays at voltages up to 300,000 and to penetrate 5 in. of mild steel and detect a cavity a little over ½ in. dia. He considers such voltages to be more for a laboratory experiment than for practical application. For ordinary practice the maximum voltage is about 220,000, which will penetrate about 3 in. of steel and detect a flaw as small as 3 per cent. of the thickness. The visual X-ray examination is not very satisfactory, as it is limited to thicknesses below ½ in., and it is generally necessary to resort to photographs. The Admiralty has recently been making inquiries for steel castings to be subjected to X-ray examination, so that it will soon be necessary to make arrangements for such examination.

Book Review.

Practical Iron Founding, by Joseph G. Horner (5th edition). Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 10s.

In the preface to the 4th edition, we are told that "certain portions, notably that of machine moulding, have been wholly rewritten." If this is so, we cannot congratulate those responsible for the revision. Many of the machines illustrated are said to be supplied by the London Emery Works Company, which concern closed their moulding-machine department shortly after the war. The business of Messrs. Samuelson, of Banbury, another firm mentioned as making moulding machines, has been transferred to Messrs. Alldays & Onions, whilst the Herrmann machine is sold by Pneulec, Limited, and not by the Pneumatic Engineering Appliances Company. The sand slinger is not mentioned, and when dealing with the hydraulic method of moulding, the Ronceray type has been forgotten. Obviously, we have a pretty poor appreciation of the revision. This same carelessness is prevalent throughout the whole book. Plate III illustrates a bunch of old-fashioned ladles made by Messrs. Thwaites Brothers—a firm which went out of existence several years ago.

As an introduction Chapter I will stand, but Chapter II, Sand Preparation, requires much revision, even from an elementary standpoint, as modern machines, like the Simpson, Rotoil and Royer, should be included and some of the obsolete machines should be deleted. Again, the word "grinding," as applied to sands, now has no place in foundry practice.

In Chapter III, the information disclosed is in many cases incorrect and belongs to another age. Such a statement as "the proportion of combined carbon is never more than a mere trace in the grey, whilst the white iron is almost destitute of graphite carbon" is definitely misleading, whilst the commercial information as to relative quantities of pig-iron supplied to the foundries by the various areas is equally misleading. That "manganese is undesirable, producing a weak and white iron," is typical of the poor quality of the metallurgical information given.

Cupolas, blast and ladles are the subjects covered in Chapter IV. Whilst mention is made of Newten tuyeres and the steam-jet cupolas of Woodward or Herbertz, yet really interesting developments such as the Poumay and Schürmann have been omitted. The next chapter, "The Shops and Their Equipment," is quite good, as enunciating such basic desiderata as good lighting and ventilation. The note about small steel converters, as an adjunct to the iron-foundry is based on false premises and should be deleted.

Chapter VI contains some useful information on moulders' tools; it also deals with moulding boxes, but for this subject a striking omission is the neglect to mention the steel variety. When dealing with shrinkage cracks, an old-fashioned notion is perpetuated in Fig. 52 (page 117), when we are asked to believe that fracture will take place through the greatest section of a right-angled structure, because of the incidence of crystallisation at right angles to the cooling surfaces. The fact is, it just doesn't, and other theories must be postulated. Again, the author's definition of a blowhole as being limited to sizes greater than a hazel nut cannot be accepted.

The author is at his best in Chapters VIII and IX, where he describes the principles of green-sand moulding with some practical examples, and in Chapter X, where dry-sand moulding is dealt with. The next chapter, XI, which includes sand and loam cores should obviously have been extended to include oil-sand cores. Loam moulding, the subject next covered, is in every way satisfactory, as beyond minor improvements in tackle, this branch of foundrywork is much the same as it was in pre-war days.

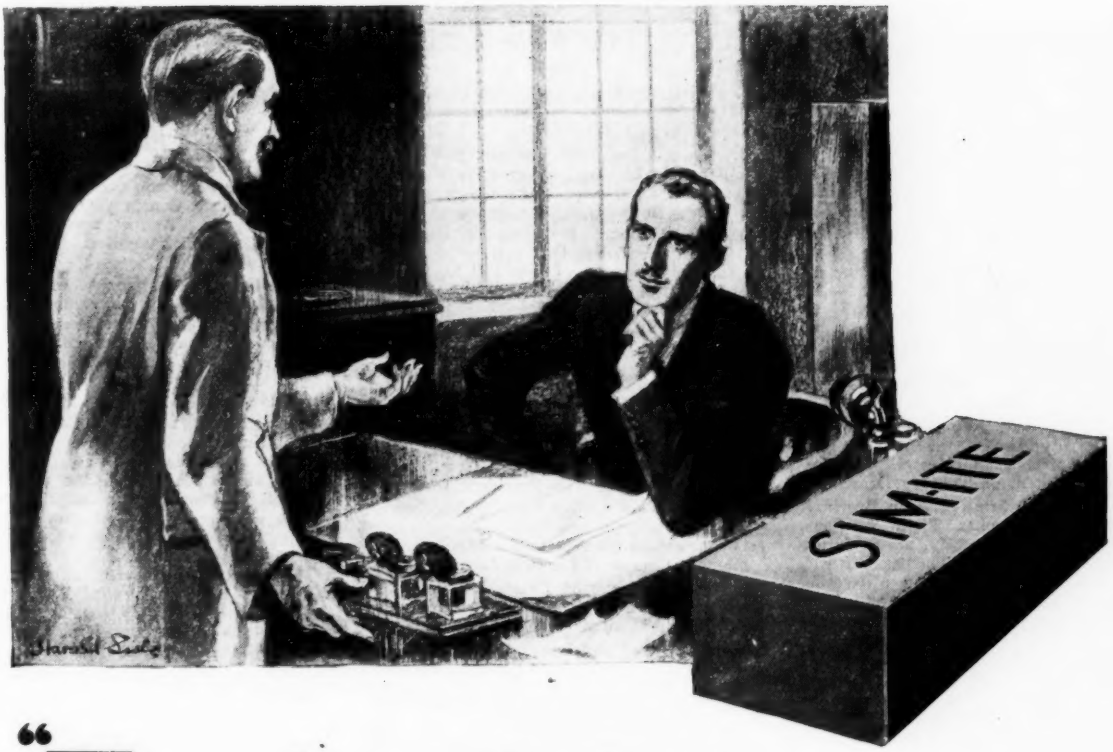
It would be interesting to learn just what particular function "anvil jaws" have in engineering practice. Those illustrated in Fig. 186, which appears in the section devoted to machine moulding, seem to us to be vice jaws. "The majority of machines have no provision for vibrating the pattern" says the author. We wonder just how true this is in 1931. We see the author credits the late Mr. James Howard, of Messrs. J. & F. Howard, as the inventor of the stripping plate, which he patented in 1856. We have already commented on the section of the book covering moulding machines, which occupies about a fifth of the whole book. The last chapter is a collection of notes covering miscellaneous economies and the weights of castings. This is followed by an appendix, which is neither well chosen nor up to date.

Finally, we cannot say that the republishing of this book, the last edition of which appeared in 1914, does credit to the publishers to whom the foundry industry is indebted for an excellent series of modern text-books dealing with much of the ground covered so inadequately by the work under review.

V. C. F.

A Large Steel Casting.—What is claimed to be the largest steel casting in the world, having a weight of 460,000 lbs., was recently exhibited at the Lehigh plant of the Bethlehem Steel Company, Bethlehem, Pa. The casting is a cylinder jacket, for the 14,000-ton forging press of the Bethlehem plant. Six open-hearth furnaces were used for the melting of the steel. One problem was the difficulty in getting these six furnaces ready to tap at the proper time. Metal for the casting was poured simultaneously through four different runners, or troughs, one at each end of the mould and two at the side.—"Steel."

XUM



"They're giving us excellent service"

"How's that test going with No. 8 Furnace, Blythe?"

"You mean the one we liked with those Gibbons' Refractories, Mr. Broadbent?" "Very well, indeed—they're giving us excellent service. We used to renew the side walls and roof every six months with the old sort of brick, but I reckon these'll last for at least a couple of years."

"H'm. That's an economy. Wish we'd tried them out before. It's going to pay us to use Gibbons' Refractories in future. Let's see—they've got a Consulting Service Department, haven't they?"

"That's so—very helpful I've found them, too."

"Well, ask someone to come along, and we'll get their advice on the best linings for *all* our furnaces."

If you, too, are interested in better and more economical furnace linings, ask for a representative to call, or send for illustrated Catalogue.

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GIBBONS (DUDLEY) LIMITED, ***Head Office:*** **Dibdale Works, Dudley, Worcs.**

Phone: Dudley 3141. *Telegrams: "Machine, Lower-Gornal."*

London Office: **151, Palace Chambers, S.W.1.** *'Phone: Victoria 0128.*

(Adjacent Westminster Tube Station)

Streets

Trade Talk.

The directors of Messrs. John Baker & Bessemer, Limited, have declared a dividend for 1930 of 4 per cent., less tax.

Messrs. R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, have despatched two rolls to the Port Talbot Steel Works, South Wales, which are 43½ in. dia. in the barrel and 12 ft. long. This is the third order for such rolls which Messrs. Tennent have completed.

Associated Electrical Industries, Limited, are reported to have received extensive contracts for railway electrification works in Hungary. The work consists of the electrification of a 60-mile stretch of the Budapest-Vienna railway line, and will be carried out in co-operation with Hungarian firms.

The 20,500-ton passenger ship "Monarch of Bermuda," built at the Walker yard of Messrs. Vickers-Armstrongs, Limited, Newcastle-upon-Tyne, was launched by Lady Lewis, the wife of Sir Frederick Lewis, chairman of Messrs. Furness, Withy & Company, Limited, on Tuesday, March 17.

The two Sheffield steel firms of John Brown & Company, Limited, and Thomas Firth & Sons, Limited, which amalgamated recently, are in future to be known under one title as Thomas Firth & John Brown, Limited. Notices calling a meeting to change the name have been issued, and it is expected that the change will be effected before the end of this month.

The Central Electricity Board has placed through its consulting engineers, Messrs. Kennedy & Donkin, a contract with W. T. Henley's Telegraph Works Company, Limited, for overhead primary transmission lines in connection with the South-West England and South Wales section of the "grid" scheme. The contract includes the supply and erection of 257 route miles of transmission line, with steel-cored aluminium conductors on lattice-steel towers, for a working pressure of 132,000 volts.

The Home Secretary gives notice, in pursuance of Section 80 of the Factory and Workshop Act, 1901, that he has certified the use of jib cranes to be dangerous, and that he proposes to make regulations, under Section 79 of the Act, in respect of the use of jib cranes, to apply to all factories and workshops. Copies of the regulations proposed to be made may be obtained on application to the Chief Inspector of Factories, Home Office, Whitehall, London, S.W.1. Any objections to the draft regulations must be sent in within 40 days of March 3.

New Companies.

Sheffield Ingot Casting Company, Limited, 186, Solly Street, Sheffield.—Capital £10,000. Directors: E. N. Horton and J. H. Freeborough.

Associated Aluminium Company, Limited, Turnbull's Chambers, 14, High Street, Coventry.—Capital £5,000. Secretary: F. H. Hodierne.

B. & F. Carter & Company, Limited, Lark Works, Hare Street, Rochdale.—Capital £1,500. Ironfounders, etc. Directors: B. Carter and Mrs. E. Carter.

Nant-y-Cyff Silica Mines, Limited, Nant-y-cyff, Caerinion Fechan, Montgomery.—Capital £3,000. Directors: H. J. Wright, H. E. Dallow, W. Round and E. B. Tromans.

Prince-Smith & Stells, Limited.—Capital £400,000. Textile machinery manufacturers, etc. Directors: Sir Prince Prince-Smith, Bt., W. Prince-Smith, A. Stell, J. Stell, J. H. Smith and D. Waterhouse. Solicitors: Clifford-Turner, Hopton & Lawrence, 81-7, Gresham Street, London, E.C.

Pig Iron for Stock.

Recently Sir Joseph Calvert, of Middlesbrough, submitted proposals to the President of the Board of Trade for stimulating and alleviating unemployment by an arrangement under which the Government would finance the making of pig-iron for stock. Sir Joseph has now been informed that his scheme has been rejected by the Government. One of the reasons given by Mr. Graham for the Government's refusal to adopt the plan is that pressure would arise for the extension of the scheme to a number of other industries now suffering from undue unemployment.

Personal.

Dr. R. Seligman was re-elected President of the Institute of Metals at the annual meeting of the Institute in London last week.

Mr. H. H. Shepherd, metallurgist to Messrs. Crane-Bennett, Limited, informs us that his permanent private address, after to-morrow, will be 146, Nacton Road, Ipswich

Mr. John Hodge, President of the Iron and Steel Trades Confederation, will retire next June. Mr. Hodge is 76 years of age, and has been President of the Confederation since it was formed in 1916.

Mr. N. McManus, M.B.E., of the Argus Foundry, Thornliebank, has been nominated for the position of President of the Scottish Branch of the Institute of British Foundrymen, in succession to Mr. James Miller. Mr. H. D. Campbell, of Messrs. Shaw (Glasgow), Limited, and Mr. J. Currie, of the North British Steel Foundry Company, Limited, Bathgate, have been nominated for the positions of Senior and Junior Vice-President respectively.

Wills.

Birks, Alfred, a director of the Meadow Foundry Company, Limited, Mansfield £42,500

Hawthorne, W. H., of Coseley, Staffs, late chairman of the Cannon Iron Foundries, Limited £74,897

Wilson, Cecil, of Norfolk, chairman of Messrs. Laurence, Scott & Electromotors, Limited **£58,804**

Vernon, John, managing director of Messrs. Wm. Heaton & Company, Limited, brass and iron founders, Rotherham £17,968

Walker, C. G., of Worksop, engineer, late of the Brightside Foundry & Engineering Company, Limited, and Messrs. Armstrong, Whitworth & Company, Limited £3,453

Leader, Robert, of Sheffield, chairman of Messrs. Joseph Rodgers & Sons, Limited, cutlery manufacturers, and a director of Messrs. Davy Bros., Limited, engineers and ironfounders £67,668

Reports and Dividends.

Scottish Iron & Steel Company, Limited.—Profit, £14,150; brought in, £3,536; preference dividend, £13,950; carried forward, £3,736.

British Insulated Cables, Limited.—Brought in, £280,807; final dividend on the ordinary shares of 10 per cent., making 15 per cent. for 1930; to reserve and depreciation, £220,000; carried forward, £279,000.

Stewarts & Lloyds, Limited.—Profit, £590,000; brought in, £125,000; depreciation, £200,000; dividend on the deferred capital of 9d. per share for the year, less tax; income-tax reserve, £50,000; general reserve, £100,000; carried forward, £133,000.

W. Canning & Company, Limited.—Net profit, £52,937; brought in, £12,951; dividend on the ordinary shares of 10 per cent. for the year, and a bonus of 1s. per share, £34,875; reserve, £15,000; employees' benevolent trust fund, £1,000; carried forward, £15,013.

Imperial Chemical Industries, Limited.—Gross profit, £5,129,757; obsolescence reserve, £500,000; income-tax, £156,365; net profit, £4,473,392; brought in, £349,926; preference dividend absorbs £1,554,554; final dividend on the ordinary shares of 3 per cent., making 6 per cent. for the year; carried forward, £653,483.

Millom & Askam Hematite Iron Company, Limited.—Gross profit, £76,139; brought in, £55,658; debenture stock interest and redemption fund, £9,303; reserve for income-tax, £5,000; reserve for depreciation, £30,000; net profit, £26,030; preference dividend absorbs £24,500; carried forward, £55,658.

Beyer, Peacock & Company, Limited.—Trading profit, £132,360; brought in, £9,261; net profit, after providing for debenture interest, depreciation, etc., and writing off £2,364 from works reorganisation suspense account, £87,259; dividend on the ordinary shares of 8 per cent.; to reserve, £40,000; carried forward, £16,020.

Obituary.

Mr. Michael J. Killeen, a native of England, and formerly assistant superintendent of the Edgar Thomson blast furnaces of the Cargenie Steel Company, died in Pittsburgh on February 19, at the age of 73 years.

Mr. R. J. Doty, plant manager of the Reading Steel Casting Company, Reading, U.S.A., died on February 24. A few weeks before he had been nominated a director of the American Foundrymen's Association.

We regret to announce the death of Mr. James B. Richardson, of Cowbridge, who was connected for many years with Messrs. Brown Lenox & Company. The deceased gentleman was the father of Mr. R. J. Richardson, the chairman of the Wales and Monmouth Section of the Institute of British Foundrymen.

Sir Archibald John Campbell Ross, K.B.E., managing director of Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Newcastle-upon-Tyne, died on March 16, at the age of 64 years. He joined the company as an apprentice in 1885, in 1910 was appointed a director of the company, and three years later became managing director of the marine-engine works. He was also a director of Messrs. Ruston Bucyrus, Limited, of Lincoln. He was President of the Engineering Employers' Federation from 1926 to 1930, and a Past-President of the North-East Coast Institute of Engineers and Shipbuilders.

We regret to announce the death of Mr. Sidney Flavel, chairman of Messrs. Sidney Flavel & Company, Limited, Eagle Foundry, Leamington, at the age of 84 years, on March 16. He was the great-grandson of the founder of the company, and started his career with the concern in 1867. Mr. Flavel devoted a great portion of his life to public affairs. He was Mayor six times, appointed Justice of the Peace in 1876, alderman in 1884, and hon. freeman in 1910 of the Borough of Royal Leamington Spa, and Justice of the Peace in 1896 and alderman in 1889 of the County of Warwick. His son and grandson will carry on the firm.

Mr. Robert Woodward, who was in his 88th year, has died at Bournemouth. Mr. Woodward was a well-known figure in the steel trade, particularly in Sheffield. He was secretary in 1886 of the Titanic Steel & Iron Company, Forest of Dean, and in that connection he was closely associated with Mr. Robert Mushet, the inventor of self-hardening steel. In 1871, he joined Messrs. Samuel Ogden & Company, of Sheffield, later going into partnership with Mr. Edgar Allen in 1890, and becoming in 1915 chairman of Messrs. Edgar Allen & Company, Limited. He resigned his seat on the board of directors of that company two years ago owing to advancing years.

Applications for Trade Marks.

The following list of applications to register trade marks is taken from the "Trade Marks Journal":

Arrow device, with the words "Golden Arrow Rolled Metal."—Non-ferrous metals. Emery Bros., Limited, 389, Lichfield Road, Aston, Birmingham.

"Coval."—Metal castings in the rough. Coventry Malleable & Aluminium, Limited, Lincoln Street, Coventry.

"Poldi" and "Anticorro."—Steel. Poldihütte (of Prague), c/o Marks & Clerk, 57, Lincoln's Inn Fields, London, W.C.2.

"Brotox."—Non-ferrous metals and metal alloys. The Broughton Copper Company, Limited, Blackfriars Road, Salford, Manchester.

Iron and Steel Output in February.

The National Federation of Iron and Steel Manufacturers report that the number of furnaces in operation at the end of February was 81, a net decrease of 2 since the beginning of the month. The production of pig-iron in that month amounted to 320,200 tons, compared with 337,200 tons in January. The February output of steel ingots and castings amounted to 486,400 tons, compared with 402,200 tons in January.

TO BRITISH STEELFOUNDERS.

FOREIGN SANDS!

IS THIS THE TIME TO THROW MORE BRITONS OUT OF WORK BY BUYING STEEL FOUNDRY SANDS FROM ABROAD, AND ESPECIALLY FROM PEOPLE WHO SPEND THE REST OF THEIR TIME IN SELLING STEEL CASTINGS AT DUMP PRICES, AND ROBBING YOU OF YOUR TRADE?

ASK YOURSELVES!

General Refractories Ltd., Sheffield (Tel. 22311), can supply "YORKSHIRE SAND" in any strength desired, and at prices more economical than any foreign sand.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The condition of this market is still far from satisfactory. In the past weeks business has been below normal, and there has not yet been an expansion sufficient to warrant the restarting of even one more blast furnace. However, the output is passing promptly into consumption, stocks have been reduced to very small proportions, and there is a more hopeful feeling amongst traders. Quite a few pig-iron contracts will expire at the end of the month, and renewals promise an early acceleration of business in Cleveland iron. A few fairly substantial orders have been placed with the local foundries, and these will involve a bigger consumption of pig-iron, while the steelworks are also making steady calls on the output of the blast furnaces. But the demand is almost entirely local. Meanwhile prices are steady, and business is chiefly restricted to small parcels for prompt delivery at the following prices:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton, f.o.t. or f.o.b.

Prices in the East Coast hematite market are falling, despite all resistance. Certain makers refuse to sell at the prices now ruling, and, despite large stocks, are waiting for higher values. However, supplies are available from other sources at 67s. 6d. per ton for East Coast mixed numbers and 68s. for No. 1 quality, at which figures a few small export orders have been secured to supplement the home demand. In the North-West of England, Bessemer mixed numbers are still quoted at 68s. per ton at works.

LANCASHIRE.—In some quarters a change for the better in the condition of this market is reported. Not all sellers of Midland brands of foundry iron will agree upon this, but, nevertheless, actual orders during the past week are reported to have been on a bigger scale than in any one week for nine months. This expansion cannot be wholly attributed to better conditions at Lancashire foundries, although brighter reports from one or two have been circulating this week. It is evident, however, that consumers are at last realising that pig-iron prices are more likely to tend upward than downward, and that on this account a number of users have deemed it expedient to replenish stocks, which, for a long time, have been allowed to reach low levels. Prices are as follow:—Derbyshire and Staffordshire No. 3 foundry, 69s. 6d.; Northamptonshire foundry, 68s.; Derbyshire forge, 64s. 6d.; North-East Coast foundry, 71s.; Scottish foundry iron, 90s. to 91s.; West Coast hematite, 82s. 6d., all per ton delivered Manchester.

MIDLANDS.—There is little change in the position of this market. Generally speaking, the ironfounders are short of work, and are buying their requirements in small quantities to cover current needs. There is only a small demand for forge pig-iron. The hematite market is quiet, with buying confined to moderate tonnages. The prices quoted by the furnaces for delivery to Birmingham and Black Country stations are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—In Scotland there is little demand for pig-iron of any kind. Only three furnaces are making foundry iron, and even this small number may be reduced. The light-castings founders have a moderate amount of employment, but most of the other founders are working only intermittently. The price of Scottish foundry iron is 73s. 6d. per ton, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. There is little inquiry for Middlesbrough iron. Continental No. 3 can be obtained at 53s. 6d. f.o.t. Grangemouth, and Middlesbrough No. 3 at 60s.

Finished Iron.

The market remains generally dull and inactive, and at the mills part-time working is fairly common. Crown bars are offered at between £9 10s. and £10 5s., and nut and bolt bars in the region of £8 15s. Staffordshire marked bars remain at £12 10s. at works. The mills making this grade of iron are better situated than those producing the cheaper qualities, but they also are short of business. The Staffordshire makers of nut and bolt iron receive little support from consumers, as the Continental prices range so low. Belgian No. 3 nut and bolt iron is quoted at prices between £4 15s. and £4 17s. 6d., showing a margin of at least £4 under the home level. The bulk of the business emanating from the Black Country for common work thus goes to the Continental mills, solely on account of the disparity in price.

Steel.

Orders for finished steel are chiefly confined to small tonnages. The demand for plates and sections remains small, and the position at several of the works is causing anxiety. The small-steel-bar market shows no change, and no improvement is recorded by the sheet makers. Galvanised steel sheets still have a decidedly depressed market, and there are no signs of any revival in the demand. The market for semi-finished steel remains quiet. There has been a little more inquiry circulating recently, but few orders have resulted. Prices for British semis are maintained, although it is possible to shade them for a substantial order.

Scrap.

There is still no sign of improvement in the Cleveland iron- and steel-scrap market. Purchases are being restricted as much as possible, and consumers are not to be tempted into forward commitments by the present low prices. Buyers refuse to speculate beyond their visible needs. Ordinary-quality cast-iron scrap is quoted at 48s. 6d., and good machinery quality at 50s. In the Midlands there is no change whatever in the position. In Scotland there is little or no demand. Stocks are accumulating once more. Consumption is small, and even deliveries against contracts are restricted. First-class machinery metal in pieces not exceeding 1 cwt. is at 53s. 6d. to 55s. Ordinary cast-iron scrap to the same specification is quoted at 48s. 6d. to 50s. The above prices are all delivered consumers' works.

Metals.

Copper.—The American statistics for February were not particularly interesting. Perhaps the most outstanding feature was the reduction of nearly 8,000 tons in the stocks of blister copper. The production of refined copper was below that of January, due entirely to the shorter month. The American position is apparently steadier, and no doubt the producers will be encouraged to hope for better conditions in the future.

Closing quotations :—

Cash.—Thursday, £45 2s. 6d. to £45 5s.; Friday, £45 1s. 3d. to £45 2s. 6d.; Monday, £44 16s. 3d. to £44 17s. 6d.; Tuesday, £44 16s. 3d. to £44 18s. 9d.; Wednesday, £44 11s. 3d. to £44 12s. 6d.

Three Months. — Thursday, £45 15s. to £45 17s. 6d.; Friday, £45 11s. 3d. to £45 12s. 6d.; Monday, £45 5s. to £45 6s. 3d.; Tuesday, £45 6s. 3d. to £45 7s. 6d.; Wednesday, £45 1s. 3d to £45 2s. 6d.

Tin.—Buying has been rather spasmodic in America, but fairly steady in Europe. Sentiment appears to be better than it was, and there is a tendency to look for a definitely higher price later on in the year, when the restriction scheme is making itself felt in earnest. Eastern sales have been fairly heavy. Statistically, the position is not too good, but the situation seems to be well in hand.

Official closing prices :—

Cash.—Thursday, £122 2s. 6d. to £122 5s.; Friday, £121 12s. 6d. to £121 15s.; Monday, £121 7s. 6d. to £121 10s.; Tuesday, £123 to £123 2s. 6d.; Wednesday, £123 2s. 6d. to £123 5s.

Three Months.—Thursday, £123 12s. 6d. to £123 15s.; Friday, £123 to £123 2s. 6d.; Monday, £122 17s. 6d. to £123; Tuesday, £124 10s. to £124 12s. 6d.; Wednesday, £124 12s. 6d. to £124 15s.

Spelter.—There has been a relapse in the improving sentiment of this market, and there has been considerable liquidation. No improvement has been shown in the trade demand, and sellers have been forced to dispose of metal on the London market.

Daily fluctuations :—

Ordinary. — Thursday, £12 3s. 9d.; Friday, £12 1s. 3d.; Monday, £12 2s. 6d.; Tuesday, £12 3s. 9d.; Wednesday, £12 1s. 3d.

Lead.—This market has been disappointing. The demand is insignificant, and there is no improvement in the absorption of the metal.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £13 5s.; Friday, £13 2s. 6d.; Monday, £13 1s. 3d.; Tuesday, £13 1s. 3d.; Wednesday, £13.

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

4,168. White & Poppe, Limited, and Thompson, J. S. Heat treatment of cast iron. **341,738.**

13,213. Rondel, F., and Iochum, G. Casting machines. **341,816.**

528 and 529. New Jersey Zinc Company. Zinc base alloys. **341,409.**

28,765. Nitralloy, Limited. Steel alloys. **341,907.**

31,750. Sergeson, R. Nitrogenising alloy-steel articles. **341,912.**

31,902. Wolf, G. Method and apparatus for manufacturing wire ropes, etc. **341,867.**

31,975. Krupp Akt.-Ges. Friedrich-Alfred-Hütte, F. Refining of iron or steel. **341,915.**

31,979. Kroll, W., and Hüttenwerke Trotha Akt.-Ges. Treatment of copper-containing alloys. **341,889.**

32,072. British Thomson-Houston Company, Limited. Electric furnaces. **341,946.**

32,314. Ahlmann, N. Process of and apparatus for grinding slag, etc. **341,951.**

32,470. Harvey, A. H., and Ebbw Vale Steel, Iron & Coal Company, Limited. Railway sleepers. **341,965.**

2,795. Hardinge Company, Inc. Apparatus for disintegrating ore and other material. **342,130.**

3,398. Levy, S. I., and Gray, G. W. Production of iron compounds and of chlorine. **342,140.**

4,131. Birmingham Aluminium Casting (1903) Company, Limited, and Pritchard, P. Light metal alloy. **342,152.**

8,056. White, A. E. (Morgan Construction Company). Art of treating metal rods subsequently to a rolling operation. **342,189.**

15,705. Boehringer & Soehne Ges., C. F. Protection of metals and their alloys. **342,235.**

32,200. Goetz, Dr. C. Obtaining metals from bituminous ores. **342,293.**

32,374. Boulanger, C. Protecting aluminium, magnesium, or their alloys against the action of corrosive agents. **342,256.**

32,477. Kuehnrich, P. R. Manufacture of malleable iron-chromium alloys. **342,295.**

32,621. Midland Motor Cylinder Company, Limited, Pritchard, P., and Picken, T. W. Manufacture of cast-iron alloy articles. **342,334.**

33,697. Waldrich Ges., H. A., and Eyermann, P. Process and apparatus for shaping and cleaning up ingots to facilitate subsequent rolling or forging operations. **342,376.**

33,785. Vereinigte Stahlwerke Akt.-Ges. Manufacture of iron and steel articles which are subjected during manufacture to the action of a testing load. **342,378.**

Messrs. Thomas L. Hale (Tipton), Limited, have received a substantial order for malleable-iron deadlight castings in connection with the new Cunarder building at Clydebank.

Sterling

ROLLED STEEL

MOULDING BOXES

INCREASE OUTPUT

AND

CHEAPEN PRODUCTION

In the course of a day's work each box part must be handled several times. For quantity production, therefore, light moulding boxes are essential.

To withstand the brunt of rapid handling and the heavy pressures of the modern moulding machine, the box must be strong, rigid and unbreakable.

For the production of castings true to pattern free from fins and crossed joints, accurate moulding boxes are not only necessary but vital.

THE SOLUTION IS

THE STERLING ROLLED STEEL BOX

In no other type of moulding box will you find such uniform accuracy of pins and parting faces, nor just that correct ratio of the necessary factors to ensure long life without undue weight.

LET US HAVE YOUR ENQUIRY FOR YOUR NEXT LOT OF BOXES.

STERLING FOUNDRY SPECIALTIES LTD.

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Code: WESTERN UNION.

Glasgow: ALBERT SMITH & CO., 60, St. Enoch Square, GLASGOW, C.1.
Newcastle-on-Tyne: LAWSON, WALTON & CO., LTD., Handyside Arcade, NEWCASTLE-ON-TYNE.
Manchester: F. L. HUNT & CO., Chapel Street, SALFORD, MANCHESTER.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	44	11	3
Three months	45	1	3
Electrolytic	47	10	0
Tough	45	5	0
Best selected	45	15	0
Sheets	77	0	0
India	59	0	0
Wire bars	48	15	0
Do., May	48	15	0
Do., June	48	15	0
Ingot bars	48	15	0
H.C. wire rods	50	10	0
Off. av. cash, February	45	8	3¾
Do., 3 mths., February	45	6	1½
Do., Sttlmnt., February	45	8	1½
Do., Electro, February	48	4	4½
Do., B.S., February	47	5	0
Do., wire bars, February	48	9	9
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7d.

BRASS.

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	9¾d.
Rods, extd. or rlld.	5¼d.
Sheets to 10 w.g.	8¾d.
Wire	8¾d.
Rolled metal	7¾d.
Yellow metal rods	5½d.
Do. 4 × 4 Squares	6d.
Do. 4 × 3 Sheets	6½d.

TIN.

	£	s.	d.
Standard cash	123	2	6
Three months	124	12	6
English	124	15	0
Bars	126	10	0
Straits	126	0	0
Australian	124	10	0
Eastern	125	12	6
Banca	126	0	0
Off. av. cash, February	118	0	0¾
Do., 3 mths., February	119	9	3
Do., Sttlmt., February	118	0	3

SPELTER.

	£	s.	d.
Ordinary	12	1	3
Remelted	11	0	0
Hard	9	5	0
Electro 99.9	14	7	6
English	12	10	0
India	10	15	0
Zinc dust	20	0	0
Zinc ashes	3	0	0
Off. aver., February	12	9	11½
Aver. spot, February	12	6	0¾

LEAD.

	£	s.	d.
Soft foreign ppt.	13	0	0
English	14	10	0
Off. average, February	13	9	11¼
Average spot, February	13	8	10½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	21	0	0
Do., V.M. ex-whf.	20	0	0
Rods	23	5	0
Boiler plates	14	5	0
Battery plates	16	0	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	36	0	0
Chinese	25	0	0
Crude	22	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	10	0
45/50%	11	0	0
75%	18	5	0
Ferro-vanadium—			
35/40%	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£15	10	0
Ferro-tungsten—			
80/85%	2/– lb.		
Tungsten metal powder—			
98/99%	2/3 lb.		
Ferro-chrome—			
2/4% car.	£29	0	0
4/6% car.	£21	10	0
6/8% car.	£20	0	0
8/10% car.	£20	0	0
Ferro-chrome—			
Max. 2% car.	£31	0	0
Max. 1% car.	£34	2	6
Max. 0·70% car.	£36	17	6
70%, carbon-free	10d. lb.		
Nickel—99%	£170 0 0 to £175 0 0		
Ferro-cobalt	9/3 lb.		
Aluminium 98/99%	£85	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£11	0	0
76/80% packed	£12	0	0
76/80% export	£ 9	0	0
Metallic manganese—			
94/96% carbonless	1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/64 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales						
Heavy steel				2	7	6
Bundled steel and shrngs.	1	17	6 to	2	2	6
Mixed iron and steel	2	0	0 to	2	1	6
Heavy cast iron	2	9	0 to	2	11	0
Good machinery for foundries				2	12	6
Cleveland—						
Heavy steel				2	5	0
Steel turnings				1	10	0
Cast-iron borings				1	5	0
Heavy forge				2	15	0
W.I. piling scrap				2	11	6
Cast-iron scrap	2	8	6 to	2	10	0
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought				3	0	0
Steel turnings					—	
Scotland—						
Heavy steel				2	5	0
Ordinary cast iron				2	8	6
Engineers' turnings				1	15	0
Cast-iron borings				1	12	6
Wrought-iron piling				2	15	0
Heavy machinery				2	13	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	38	0	0
Brass	26	10	0
Lead (less usual draft)	11	10	0
Tea lead	8	10	0
Zinc	6	15	0
New aluminium cuttings	50	0	0
Braziery copper	35	0	0
Gunmetal	36	0	0
Hollow pewter	76	0	0
Shaped black pewter	56	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/–
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/–
Hematite No. 1	68/–
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	75/6
,, d/d Birm.	86/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	66/–
,, No. 3 fdry.*	71/–
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	62/6
,, fdry. No. 3*	67/6
,, fdry. No. 1*	70/6
Derbyshire forge*	66/–
,, fdry. No. 3*	71/–
,, fdry. No. 1*	74/–
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	76/–
,, No. 3	73/6
Hem. M/Nos. d/d	74/–
Sheffield (d/d district)—	
Derby forge	61/–
,, fdry. No. 3	66/–
Lincs forge	—
,, fdry. No. 3	66/–
E.C. hematite	81/6
W.C. hematite	84/6
Lancashire (d/d eq. Man.)—	
Derby forge	64/6
,, fdry. No. 3	69/6
Staffs fdry. No. 3	69/6
Northants fdry. No. 3	68/–
Cleveland fdry. No. 3	71/
Dalzell, No. 3 (special)	105/– to 107/6
Summerlee, No. 3	90/– to 91/–
Glengarnock, No. 3	—
Eglinton, No. 3	90/– to 91/–
Gartsherrie, No. 3	90/– to 91/–
Monkland, No. 3	90/– to 91/–
Shotts, No. 3	90/– to 91/–

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	10	0	0 to	10	10	0
Nut and bolt iron				8	15	0
Hoops	10	15	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip	10	15	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				14	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	9	5	0 to	10	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	7	5	0 to	7	15	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	5	0 to	9	10	0
Black sheets, 24g.	8	10	0 to	9	10	0
Galv. cor. shts. 24g.				11	0	0
Galv. flat sheets				11	10	0
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	5	5	0 to	5	12	6
Billets, hard	7	2	6 & up.			
Sheet bars	5	0	0 to	5	12	6
Tin bars	5	0	0 to	5	12	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/–
Sheet to 10 w.g.	1/0½
Wire	1/1¼
Rods	1/–
Tubes	1/7
Castings	1/–

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/– to 10 g.	1/4½ to 1/11½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.76
No. 2 foundry, Valley	16.50
No. 2 foundry, Birm.	13.00
Basic	18.26
Bessemer	18.76
Malleable	18.76
Grey forge	17.76
Ferro-mang. 80%	80.00
O.-h. rails, h'y, at mill	43.00
Billets	30.00
Sheet bars	30.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.65
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.90
Sheets, black, No. 24	2.35
Sheets, galv., No. 24	2.90
Sheets, blue an'l'd, No. 13	2.05
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/–
,, furnace	15/– to 17/–
Durham and Northumberland—	
,, foundry	13/6 to 14/–
,, furnace	13/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	15/3 to 15/6
,,	28×20 ,,	31/–
,,	20×10 ,,	22/9
,,	18¾×14 ,,	16/3
C.W.	20×14 ,,	15/–
,,	28×20 ,,	29/6
,,	20×10 ,,	21/–
,,	18¾×14 ,,	16/–
Terneplates	28×20	31/– per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars and rods dead soft, st'l	£11 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.
Over ¼ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Mar. 12 ..	45	2	6	inc.	6/3
„ 13 ..	45	1	3	dec.	1/3
„ 16 ..	44	16	3	„	5/-
„ 17 ..	44	16	3	No change	
„ 18 ..	44	11	3	dec.	5/-

Electrolytic Copper.

		£	s.	d.	
Mar. 12 ..	48	0	0	No change	
„ 13 ..	47	10	0	dec.	10/-
„ 16 ..	47	10	0	No change	
„ 17 ..	47	10	0	„	„
„ 18 ..	47	10	0	„	„

Standard Tin (cash).

		£	s.	d.	
Mar. 12 ..	122	2	6	No change	
„ 13 ..	121	12	6	dec.	10/-
„ 16 ..	121	7	6	„	5/-
„ 17 ..	123	0	0	inc.	32/6
„ 18 ..	123	2	6	„	2/6

Tin (English ingots).

		£	s.	d.		
Mar. 12 ..	123	15	0	No change		
„ 13 ..	123	5	0	dec.	10/-	
„ 16 ..	123	0	0	„	5/-	
„ 17 ..	124	10	0	inc.	30/-	
„ 18 ..	124	15	0	„	5/-	

Zinc Sheets (English).

		£	s.	d.	
Mar. 12 ..	21	0	0	No	change
„ 13 ..	21	0	0	„	„
„ 16 ..	21	0	0	„	„
„ 17 ..	21	0	0	„	„
„ 18 ..	21	0	0	„	„

Spelter (ordinary).

		£	s.	d.		
Mar. 12 ..	12	3	9	dec.	1/3	
„ 13 ..	12	1	3	„	2/6	
„ 16 ..	12	2	6	inc.	1/3	
„ 17 ..	12	3	9	„	1/3	
„ 18 ..	12	1	3	dec.	2/6	

Lead (English).

		£	s.	d.	
Mar. 12 ..	14	15	0	No change	
„ 13 ..	14	10	0	dec.	5/-
„ 16 ..	14	10	0	No change	
„ 17 ..	14	10	0	„	„
„ 18 ..	14	10	0	„	„

Imports and Exports of Iron Castings in February and the two months 1931, compared with February and the two months 1930.

	February, 1930.	February, 1931.	Two months, 1930.	Two months, 1931.	February, 1930.	February, 1931.	Two months, 1930.	Two months, 1931.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	2,889	767	5,144	2,073	32,831	8,968	61,137	25,747
Castings, in the Rough, Iron	256	216	554	382	5,338	3,881	11,849	7,515
„ „ „ Steel	1,413	621	2,979	1,231	31,739	14,196	70,593	27,751
Hollow-ware, Cast, not Enamelled	2	6	6	15	220	369	725	1,023
„ „ Enamelled	—	26	4	27	20	996	261	1,052
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	177	87	395	190	5,536	3,474	13,797	8,696
„ British South Africa	194	106	501	263	7,724	4,708	19,260	10,928
„ „ India	165	102	342	229	5,905	3,544	12,059	7,868
„ Australia	70	15	117	31	4,204	736	7,294	1,295
„ New Zealand	139	26	229	88	8,331	1,010	13,575	5,012
Total (including other countries)	1,602	870	3,430	2,151	68,139	39,845	146,320	100,319
PIPES AND FITTINGS—CAST—								
To Argentine Republic	814	416	2,243	1,267	7,928	3,977	21,864	12,044
„ British South Africa	1,111	1,175	2,522	2,111	11,091	15,309	25,463	25,569
„ „ India	425	140	990	279	6,300	2,476	14,725	5,787
„ Straits Settlements and Malay States	120	275	1,502	352	2,165	2,889	14,024	4,335
„ Ceylon	64	32	210	39	815	368	2,448	501
„ Australia	46	47	259	77	1,027	762	4,334	1,367
Total (including other countries)	10,805	6,888	22,692	13,182	115,112	75,376	244,063	149,753
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	433	205	851	454	14,042	6,729	27,031	14,575
„ Enamelled	72	80	142	118	5,814	7,557	11,676	11,410
CASTINGS, in the rough—								
Iron	184	224	591	327	5,771	8,857	17,207	12,565
Steel	299	77	507	231	10,072	3,526	17,137	9,776

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

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LIMPET

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
19, ST. VINCENT PLACE, GLASGOW.
ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

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(A remittance should accompany instructions.)

AGENCIES.

LONDON Firm, offices Westminster, sound connection, would represent first-class firm for Steel Castings.—Box 760, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

POUMAY SYSTEM OF CUPOLA CONTROL.

DEVELOPMENT is sought for the above in the British Dominions and Colonies. Applications are invited for Agencies and from prospective purchasers of the rights.—British Drying & Heating Company, Limited, 15, King Street, London, S.W.1.

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11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

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Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

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TO Engineers, Founders, Manufacturers.—Fine site of nearly three acres on arterial road, with Foundry and Workshops and own Rail Sidings into the premises. Modern Offices, Warehouses and Workrooms. Central Heating. —Charles A. Tricks & Son, Auctioneers. St. Nicholas Street, Bristol.

MACHINERY.

WHEEL-MOULDING Machine by Buckley & Taylor, with 6-ft. table; perfect order; complete with gears; cheap.—A. Hammond, 14, Australia Road, Slough.

MACHINERY—*Continued.*

FOR Sale.—One Thwaites Bros. No. 3 Belt-driven Blower, 10-in. outlet, capable of supplying 3,000 ft. of air per min.—Farington Steel Foundry, Leyland.

I HAVE LADLES of all sizes in stock from 1 cwt. up to 16 tons; I send any ladle on approval. Inquiries for any type of Foundry Plant solicited. I have the largest stock ever collected! — A. Hammond, Foundry Machinery Merchant, 14, Australia Road, Slough.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. Brealey & Company, Limited, Station Works, Ecclesfield, Sheffield.

THOS. W. WARD, LTD.

New Pneumatic Sand Moulding Machine, admit pattern boxes 16 in. x 16 in. x 6 in.

New 15-b.h.p. Vertical Heavy Fuel Oil Engine.

285-i.h.p. Horizontal " Uniflow " Engine.

24-h.p. Vertical D.A. ALLEY & MACLELLAN Steam Engine.

1920 make 4-wheel 14-in. x 20-in. LOCOMOTIVE (Hudswell Clarke), copper firebox, steel tubes; 160 lbs. w.p.

1920 make 4-wheel 14-in. x 22-in. LOCOMOTIVE (Hawthorn Leslie), steel firebox, steel tubes; 160 lbs. w.p.

New " POPULAR JUNIOR " BOILER, 5 ft. 6 in. high x 2 ft. 6 in. dia., 100 lbs. pressure.

FOUNDRY LADLES, various types and sizes.

PRESSURE RECEIVERS, 24 ft. 0 in. x 4 ft. 6 in., hydraulically tested to 300 lbs. per sq. in.

(ASK FOR " ALBION " MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 45 years' experience.—King's Patent Agency, Limited, 146A, Queen Victoria Street, E.C.4.

MISCELLANEOUS.

OUR Moulders' Sprigs now cheaper by one shilling per cwt. See our advertisement, page 21. Also see our advertisements, pages 19 and 22, relating to Straw Ropes and Parting Powder, this Journal, March 12 issue.—Wm. Olsen, Limited, Cogan Street, Hull.

MISCELLANEOUS—*Continued.*

GANISTER, best quality for cupolas, also for Steel Works.—Astbury Silica Company, " The Brooms," Park Lane, Congleton.

ADDRESSOGRAPH Machine (Pedal), in good working order, with cabinet attached, including some drawers, for disposal.—Address replies to Box 1768, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

MOULDING MACHINES

1 " Coventry " headram squeezer, new		£22
2 Britannia No. 1 jolters new	each	£36
3 Britannia No. 2 jolters, new	each	£38
1 Britannia 20" × 16" jolt squeezer, new		£45
1 " Shockless " 72" × 60" plain jolter		£90
4 Adaptable machines, standard type	each	£14
1 Darling & Sellars 24" × 18" turnover		£14
1 Farwell type plain squeezer		£8

PLEASE NOTE PRICES!

BUY FROM ME AND SAVE MONEY!

Alex. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

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Bradley's

DEGASIFIED
REFINED PIG IRONS

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Complete Rolling Mills for all Metals.

Machinery for Making Tubes and Wire.

MILL GEARING OF EVERY DESCRIPTION.